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Power Generation

June, 1948

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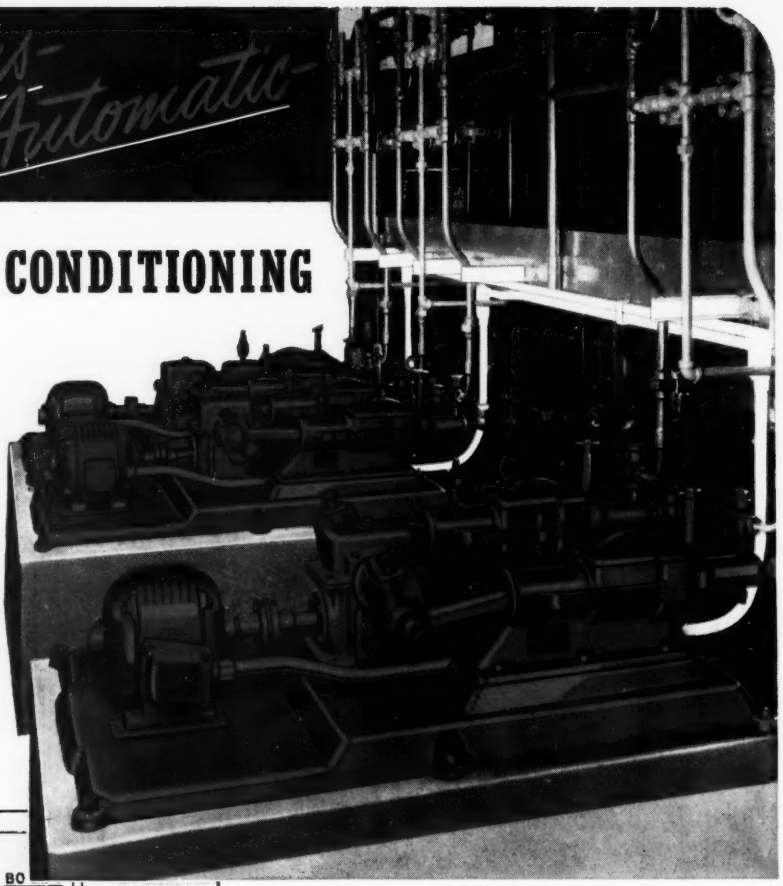
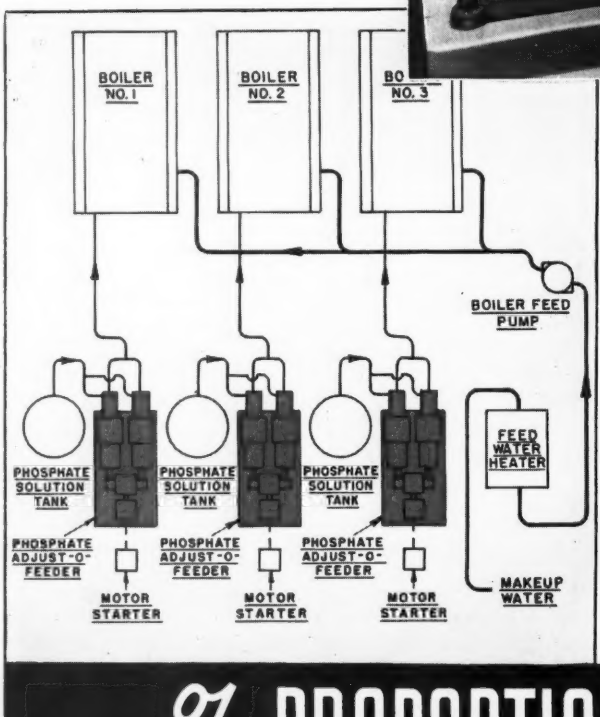
Continuous-Automatic-

BOILER WATER CONDITIONING



%Proportioneers% Equipment feeding phosphates to boiler water, United Illuminating Co. (Steel Point Station), Bridgeport, Conn. All equipment shown red in photo and flowgram furnished by %Proportioneers, Inc.%.



An adequate and regular method of injecting boiler water conditioning chemicals is a requisite in the modern power plant to prolong the life of its equipment, operate boilers at top efficiency with minimum fuel and avoid costly shutdowns for repairs and cleaning. The %Proportioneers% system adds the proper treating chemical, in the correct proportion at the right time.

Make use of the experience of America's leading chemical feeding engineers and proportioning specialists, gained in over 26,000 installations. Send details today for the complete analysis of your specific problem.

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ENGINEERS' PREVIEW

MUSIC IS ALGEBRA, according to Joseph Schillinger, who died five years ago after working out a theory that a man armed with the proper formulas could compose as easily as a musician. This has all been explained now by one Arnold Shaw, music critic, as recently reported by Robert Musel of the UP. Mr. Schillinger, it is claimed, reduced the music of Bach and Beethoven to mathematics and evolved formulas by which artists and illustrators could solve problems of coloring and composition by use of algebra. "It's a complex theory, of course," says Mr. Shaw, "but what it amounts to is that rhythm is the underlying basis of art just as it is the basis of music." As Mortimer Snerd would say, "N-n-n-n-o-o-o-Oh!" Now all that remains to be done is to insert the proper formulas in the Memex and, finally, to examine them carefully with the Oxometer.

★ ★ ★

YOU SHOULD TAKE or make time for a visit to the John Woodman Higgins Armory and Industrial Museum whenever you are anywhere near Worcester, Massachusetts. Its very able director, Charles W. Wilder, will show you an exhibit of steel products that will amaze you.

The armory and museum are in a s .on of the plant of Worcester Pressed Steel Co. It was established by the company's president, John Woodman Higgins, for several reasons. For one thing, all good craftsmen in every field like to have specimens of their own and others' work on display, for study and for historical purposes, in a congenial atmosphere. So, Mr. Higgins established this museum to inspire modern steelworkers; to attract superior recruits; to stimulate art in industry; to extol steel craftsmanship and to inform the public.

This steel collection is housed in its own steel and glass buildings adjoining the steel mills. Its interior style is appropriately Gothic. One wing is devoted to modern products, headed by those crowning examples of mass production, the modern airplane and automobile, 90 per cent pressed steel. Equipment used in manufacturing is on display. The ancient wing houses the products of our predecessors, dominated by a group of 16th century, mounted, armored knights, in full battle dress. Development may be traced from utensils of the Stone and Bronze Ages through Greek and Roman armor, then through the war implements of the early Iron Age and down to Crusaders' armor and relatively modern steel armor.

There is a relation between efficiency of function and harmony of proportion that trancends surface beauty, says Mr. Higgins, and this is modern art, so well exemplified in our modern machines of steel. We have often remarked in these pages that the lines and proportions of some of our modern steam turbines and airplanes make them truly beautiful and artistic objects. This is the sort of thing Mr. Higgins is talking about.

Mr. Wilder, the director of the museum, is far more than a guide. He is a skilled interpreter of the technical facts and artistic lore of this collection in terms of what they mean to human beings.

A trip to see this museum and meet Mr. Wilder will be well worth your while. Take your sons and daughters, too, and their friends. They'll be delighted with it. It's not just a lot of old historical stuff, but an integrated, forceful picture of the development of one of the very fundamentals of the civilization in which those young people, and all the rest of us, work and live.

ONCE MORE the monorail, extensively discussed in the technical literature of 50 years ago and actually used in a few cases, is again being advocated as a cure for some of our transit ills. It was recently proposed at the New York Railroad Club as a solution to the street traffic problem. According to Edward H. Anson, vice president of Gibbs and Hill, consulting engineers, the monorail system has been in operation in Germany on an 8-mile route since 1901. Present proposals are for vastly improved designs and a spokesman for the Monorailway Corp. says it is prepared to install such overhead systems. A monorail system is claimed to be quieter than other systems and its appearance very attractive. The supporting structure provides either an arch or a single T-shaped column and cantilever arms, each carrying a simple box girder on which the rails are placed.

This writer well remembers as a boy reading various articles on monorail systems published in such magazines as the *Scientific American* and *Popular Mechanics*. One very distinct recollection is of a photograph showing a monorail train supported on steel arches and running over a canal somewhere in Holland. Furthermore, this writer knew a New England inventor named Moody Boynton, who spent his life and a large fortune developing a single-track railway system, interested some of the leading engineers in the country in it and actually constructed an experimental track 18 miles long on Long Island, on which trains were propelled at the almost incredible speed of 60 miles an hour by electricity—all this around 1900.

★ ★ ★

ADVANCED PLANNING has been completed on a central African hydroelectric power project, which includes the damming of the Zambesi River, building of a 250-mile railroad, and installation of a 700,000-kw power station. This would permit production of 500,000 tons of pig iron and 50,000 tons of ferro-chrome a year, says the British Information Service.

★ ★ ★

THE ARTICLE University of Illinois Growth Requires Abbott Power Station Expansion, by Gordon V. Carlson, in the February 1948 issue, describes one of the outstanding institutional power plants in the country. There is an interesting angle on this article which will be apparent to anybody who examines closely the heat balance diagram of the station, Fig 4, page 55. The angle is that practically every important problem in power plant design and operation that can arise is illustrated in this plant. Generation of electricity by back pressure turbine, by extraction condensing turbine and various combinations of these conditions is one point illustrated. The plant supplies process steam and heating steam under conditions comparable to those in many industrial plants. Feedwater heating by the regenerative cycle and all the problems of feedwater treatment involved in plants having various proportions of condensate return and makeup can be studied. The problems of combustion and auxiliary equipment run the gamut of the power plant art. About the only things not included are firing of liquid and gaseous fuels, pulverized coal burning, slag tap furnaces—and reheat. As a result, the instructors in the Department of Mechanical Engineering at the University are able to use their own plant, in full operation under various conditions right on their own campus, to illustrate to their students most of the principles they are teaching in the classroom.

ELECTRONIC INSTRUMENT that looks like a pistol, but detects holes in the target instead of making them, has been developed by General Electric Co. Compounds of the halogen family such as chlorine are used as tracers, and these vapors, when leaking from boilers, pipes, tanks and other closed pressure systems, have been detected by the instrument in amounts as small as 10 parts per million.

★ ★ ★

SCIENTIFIC SURVEY combining the technical resources of the Departments of the Interior and the Navy has been started at Lake Mead to find out what sedimentation is doing to the world's largest artificial lake, created over areas of Arizona and Nevada by Hoover Dam on the Colorado River. As was anticipated when Hoover Dam was designed and built, the Colorado now drops virtually all of its heavy load of silt and sand when it enters the quiet waters of the lake. The accumulation of this sediment in 12 yr of operation has been sufficient to cause some reduction in space available for water storage. However, the accumulation has not yet been sufficient to reduce the power production or the quantities of water released for other purposes because storage space was provided for sediment when the reservoir was planned. The original designs estimated that the reduction in storage space would not materially effect operation during the 50-yr repayment period of the cost of the project. The present survey will help determine just what the status of sedimentation is at present.

★ ★ ★

WAYNE UNIVERSITY in Detroit stands ready to help commercial and industrial concerns in the production of all types of instruction materials by establishment of an Audio-Visual Materials Consultation Bureau.

Companies and associations interested in making films, booklets, charts, or specimen products available for school use can secure "one-stop" service at the Bureau. Surveys showing school needs, critical analysis of scripts and copy, and actual classroom try-out of materials in "rough" or finished form are types of help given.

The Bureau also offers assistance in the development of films, filmstrips, records, manuals, etc. to be used for instructional purposes in industrial training programs. Preparation of market analyses and distribution surveys are other kinds of service offered.

Dr. Arthur Stenius, in charge of the Bureau, has done intensive research study in the field, has had experience in the actual production of film records, and graphic materials, and was in charge of the Audio-Visual Program for the Detroit Public Schools.

★ ★ ★

FREE-PISTON gas turbine engine for a railroad locomotive and a new steam-turbine electric locomotive, designed to reduce coal consumption by one half, are among new railroad engines under development by Westinghouse. A third engine is a new and larger electric locomotive. A fourth engine, previously announced, is a gas-turbine electric locomotive designed to burn liquid fuel and operate in main line service. Details of the latter have been given by John I. Yellott in his series on the gas turbine power plant in these pages. The free-piston gas turbine engine, its principles and method of operation were described in detail in POWER PLANT ENGINEERING, April 1946. In addition to the four above projects, it is stated that Westinghouse is aggressively pressing research to determine if coal-burning gas turbines for locomotives are feasible.

USE OF NATURAL GAS by the Consolidated Edison Co. of New York is being contemplated. Transcontinental Gas Pipeline Co., Inc., is applying to transport natural gas from Texas to the New York, New Jersey and Pennsylvania area. According to Randall LeBoeuf, counsel for Consolidated Edison, the company plans to use from 73 to 80 per cent of the natural gas for manufacture of artificial gas, the remainder as boiler fuel in generating electricity. The latter use, as boiler fuel, would save approximately $650,000 a year. It would also make it unnecessary for the company to construct certain new facilities and would release for other users 211,000,000 gal of fuel oil a year. The new pipeline, the diameter of which would be greater than that of Big Inch, is estimated to cost from $150,000,000 to $157,000,000.

★ ★ ★

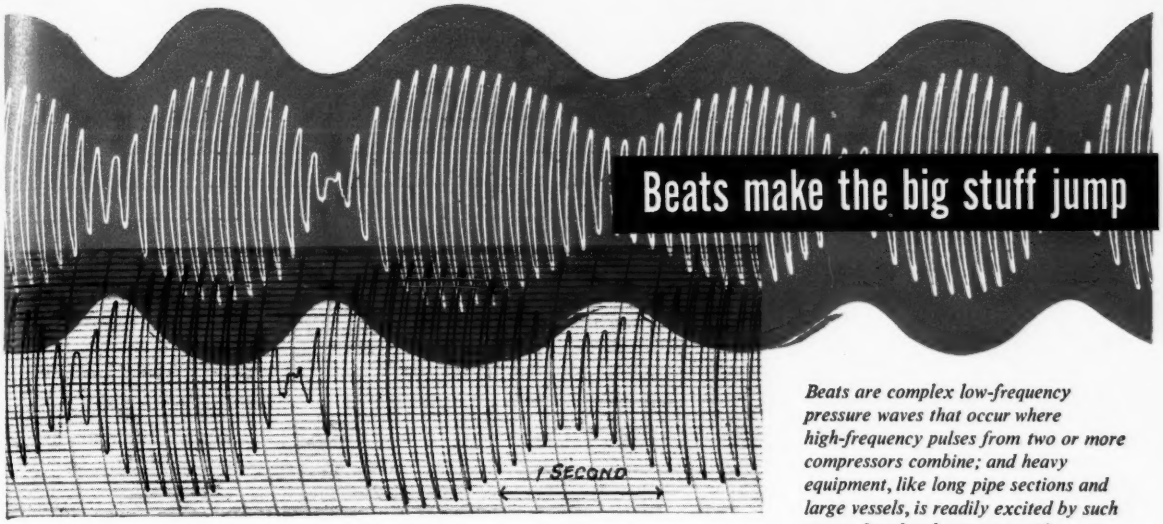
WHAT ARE THE capacities of various municipal water systems in the United States and Canada to supply water for air conditioning loads? Have engineers in general been unduly alarmed about the possibility that there would not be water enough for the air conditioning they are required to install? All over the country for the past few years there have been reports of lowered water tables and difficulties in obtaining adequate supplies of cooling water for air conditioning and other purposes.

To obtain some factual information, a survey has been conducted by S. C. Moncher and the ASRE and these data are reported in a recent issue of *Refrigerating Engineering*. So far as our municipal water supplies are concerned, it is not so much the total quantity of water available to a water works as the inflexibility of existing water supply systems that makes difficult rapid changes in the amount of water available to any given locality. Once a system of supply mains is put in place, modification of them becomes a major operation and can be undertaken only after much delay. Hence in congested areas of large cities, as the area is built up, the demand for water is likely to skyrocket and this may produce a critical situation.

Long-range planning is necessary on the part of the community. The survey reports tests made in the loop district of Chicago 10 or 12 years ago and gives a table showing the conditions in various cities throughout the country. The survey shows that, generally speaking, the problem of an adequate supply of water for air conditioning is not critical at the present time throughout the greater part of the United States and Canada. In those communities where a shortage exists, however, it is a problem of major importance to the air conditioning industry. Judicious use of water conservation devices on future air conditioning installations can do a great deal in alleviating this problem.

★ ★ ★

NEW METHOD of sealing concrete highways and air field runways against weather ravages has recently been announced by U. S. Rubber Co. A rubber compound has been developed that can be inserted in joints between concrete slabs to eliminate water seepage and to absorb expansion and compression strains without breaking and without separating from the concrete. This sealing compound obviously should be applicable to many other types of concrete construction.

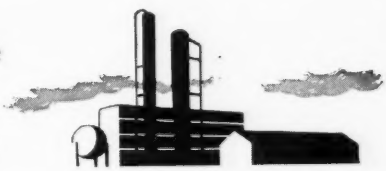


Beats are complex low-frequency pressure waves that occur where high-frequency pulses from two or more compressors combine; and heavy equipment, like long pipe sections and large vessels, is readily excited by such waves. So when beats occur, it's trouble ahead for the big stuff. (Chart shows one complete cycle of beats in a compressor suction system.)

Rx for Live Beats that should be Dead

Pulsation is potential dynamite Pulses from gas compressors prowl through pipes looking for conditions susceptible to their own frequency. When pulse frequencies and physical characteristics of the pipe are such as to establish a condition of resonance, destructive vibration follows. Failures in low pressure systems are serious; in high pressure systems they can be disastrous. Keep gas flow smooth and controlled with Fluor Pulsation Dampeners!

Pulsation also plays tricks It often makes orifice meters read wrong. It can cause excessive pressure drop in pipes. It can even cause a drop in compressor efficiency. But it does none of these things where Fluor Pulsation Dampeners are at work!



Fluor Pulsation Dampeners are built to fit each job: Any gas. Any compressor. Any pipe size. Any pressure drop.

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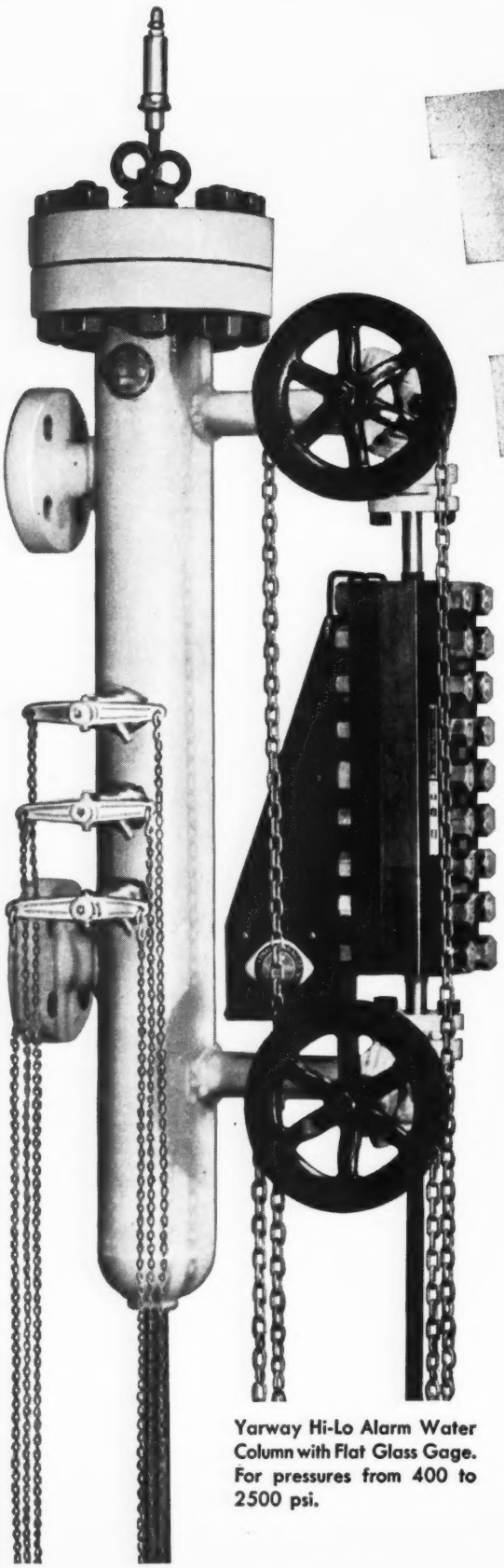
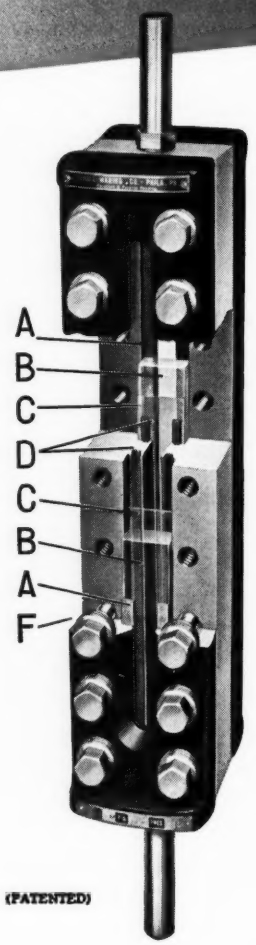
YARWAY REDUCES LEAKAGE



Yarway Hi-Lo Alarm Water Column with Flat Glass Gage. For pressures from 400 to 2500 psi.



(PATENTED)

Cut-away section of Yarway Flat Glass Gage. Shows asbestos gaskets (A) placed between cover plates and outer faces of glasses (B).

Front and back cover plates are independently fastened to body by special shouldered cap screws fitted with spring cones (F) which automatically limit the amount of pressure on glasses and gaskets and, at the same time, take up expansion and contraction. Special molded gaskets (D) provide tight pressure sealed joints between body and glasses. Inner surfaces of gage glasses are protected by India ruby mica (C).

YARWAY

"Floating Assembly"

FLAT GLASS GAGE AND GLASS BREAKAGE

Leakage between gasket and glass, or between gasket and body on flat glass gages is a frequent source of trouble to boiler plant operators. The trouble occurs when the gage cools each time it is cut out of service. Starting with dripping, the trouble becomes serious when steam blows through, cutting gasket, mica and glass... resulting in high maintenance cost.

As a cure, the cover plates are sometimes forced down hard on packings and glasses, frequently breaking glasses and thereby increasing the trouble.

Yarway has a better solution... a distinctive "floating assembly."

Careful tests in the Yarway Research Laboratory and several years of field service have shown that to prevent leakage and excessive loading of glasses, some flexible feature is required. *Spring cones under the cap nuts fastening covers and glasses in place provide this flexibility.* This spring cone loading or "floating assembly" is predetermined. The loading is maintained by accurately machined cap screws which shoulder on the insert body, limiting the spring cone load to that actually required. *Thus cover plates are independently adjusted.*

For the full story—including other features of Yarway Water Columns and Gages—write for Yarway Bulletin WG-1811.

YARNALL-WARING COMPANY • 114 Mermaid Avenue, Philadelphia 18, Pa.

BRING THE OVERHEAD GAGE READINGS DOWN TO EYE LEVEL WITH THIS YARWAY REMOTE BOILER WATER LEVEL INDICATOR

This widely used instrument brings the overhead gage reading down to eye level at any desired location. Readings are on a brilliantly-lighted dial. Indicator is always accurate because it is operated by the boiler water itself—by the pressure differential between a constant head of water and the varying head in the boiler drum. Action is instant, constant. *There are no stuffing boxes.* Easy to install and moderate in price. Suitable for all pressures to 1500 psi.

Completely described in Bulletin WG-1822

STEAM PLANT EQUIPMENT

Why still another big Turbine gets Nonpareil protection

Take a look at the record made by Nonpareil Turbine Oil in this large midwest utility plant.

Eight years ago Nonpareil was installed in one turbine—a 36,750 KW unit. Two years later a shift to Nonpareil was made on a second turbine—of 37,500 KW—and shortly after that on a third—another 36,750 KW unit.

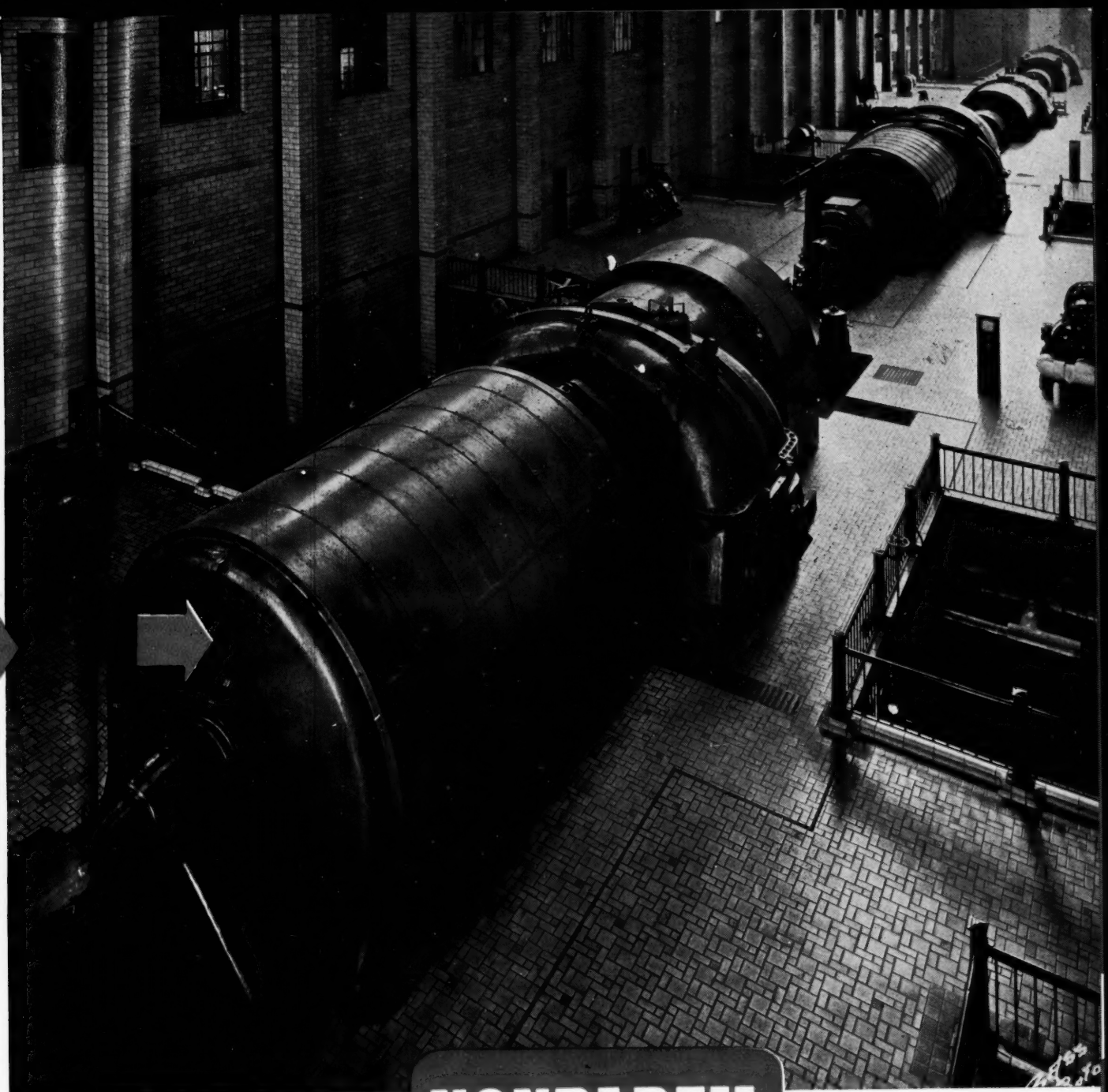
Recently a new 37,500 KW turbine was put into service, and the job of lubricating it went to Nonpareil—making a total of 148,500 KW capacity which Nonpareil protects for this one utility.

What are the facts back of this record? In the six to eight years of operation on Nonpareil, neutralization numbers have stayed between .04 and .06. Losses and troubles caused by high acidity have been completely absent.

Nonpareil is the only product in its field that carries a written guarantee to last as long as your turbine without increasing in acidity above a neutralization number of 0.15. This guarantee, backed by 20-year performance records, is your assurance of trouble-free turbine operation with Nonpareil.

If you are installing new turbines, let a Standard Oil Lubrication Engineer explain how Nonpareil brings real economy in equipment, plant space, and total investment. Write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY (INDIANA)



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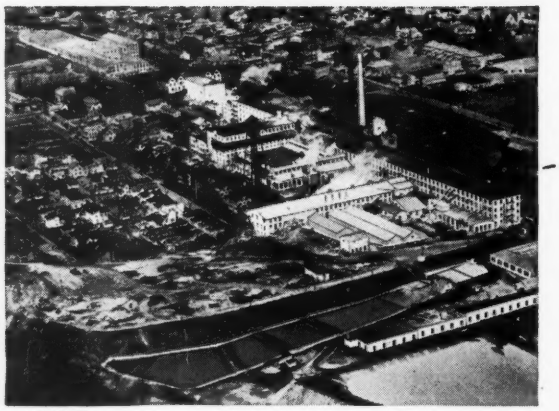
TURBINE OIL

DIANA STANDARD OIL COMPANY (INDIANA)

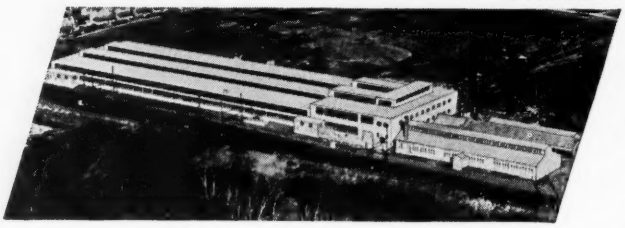
STANDARD



• AMBLER, PA.

Serving the growing needs for Asbestos . . .

• AMBLER, PA.



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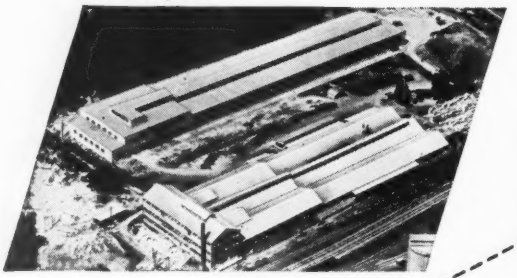

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K&M—a pioneer in the production of Asbestos and Magnesia products, operates 8 strategically located factories to handle the expanding requirements of its seven major sales divisions.

Our Research Laboratories are constantly in search of new and better ways to save and serve through improved and more efficient products.

An experienced sales engineering staff is always available to give helpful advice on the correct application of these products.

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Keasbey & Mattison has made it serve mankind since 1873

DIAMOND ANNIVERSARY 1873 1948 K&M KEASBEY & MATTISON CO.

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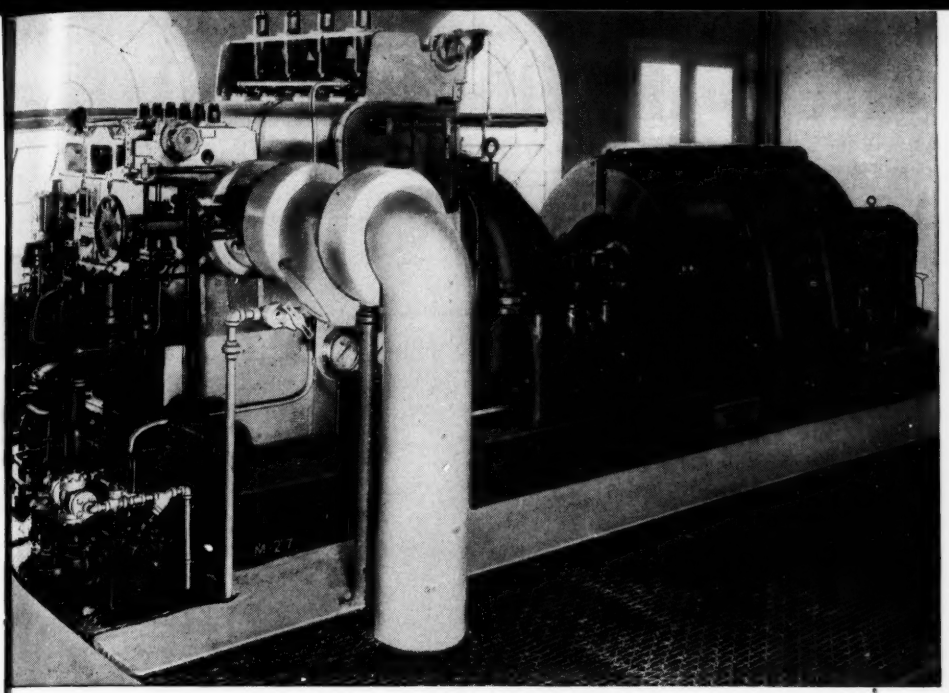
NEWS

FROM THE POWER FRONT

AS REPORTED BY THE DEVELOPMENT ENGINEERS, FIELD SERVICE REPRESENTATIVES AND CUSTOMERS OF WORTHINGTON



2000 kw Worthington Turbo-Generator—installed in 1937 at Detroit Lakes, Minnesota, power station.

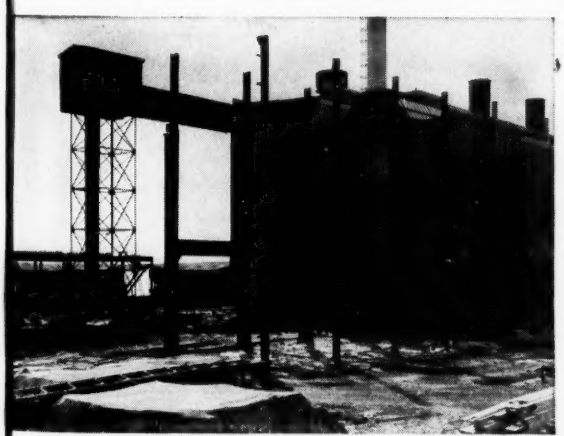
4000 kw More For Detroit Lakes

The City of Detroit Lakes, a bustling Minnesota resort center, has long taken pride in its municipally owned power plant. Through careful planning and good management, the plant has prospered . . . and the utilization of extracted steam from the generator units for heating the business district and public buildings is an advantage in Northern Minnesota measured beyond dollars and cents!

Detroit Lakes' order for a Worthington 4000 kw automatic bleeder turbine will bring to 7000 kw its total of Worthington installed turbine power. The first Worthington turbine, a 1000 kw unit, was installed in 1933; the second, a 2000 kw unit, in 1937.

The units have been inspected every two years and have been reliable and economical in operation.

Del-Mar-Va's Vienna Station Expands by Six Million



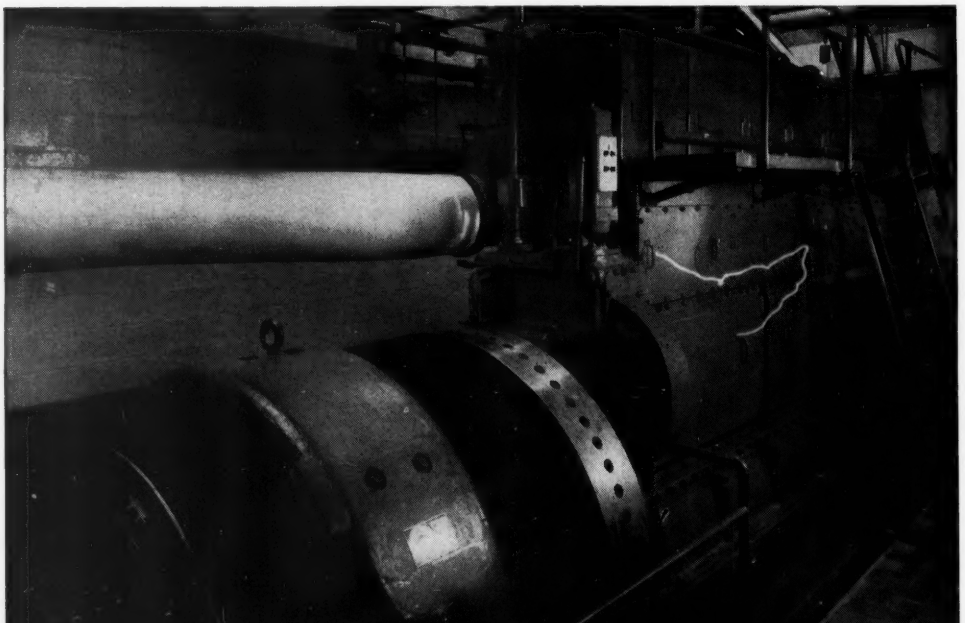
Foundations and turbine room, Vienna Generating Station of Eastern Shore Public Serv'ce Company of Maryland (United Engineers & Constructors, Inc., Philadelphia).

To provide more electrical energy to the Del-Mar-Va Peninsula, the Eastern Shore Public Service Company, a subsidiary of the Delaware Power and Light Company, is now undertaking a $6,000,000 expansion of its station in Vienna, Maryland.

Worthington was recently awarded the contract for the condensing unit to serve the latest 15,000 kw Turbo-Generator: a 14,000 sq-ft two-pass condenser with auxiliary equipment.

Four units are now in operation in this station—two 6,000 kw and two 7,500 kw. One 15,000 kw unit is being installed by the United Engineers and Constructors and a similar unit is on order. The two 6,000 kw generators operate at 300 psi, 675F, TT; the 7,500 kw and 15,000 kw units operate at 650 psi, 825F, TT.

NEWS from the power front



Worthington 750 hp Type EE-6 Diesel Engine at Lenox Hill Hospital.

Worthington Diesel at Lenox Hill Hospital

A 750 hp Type EE-6 Worthington Diesel engine installed in the power plant of Lenox Hill Hospital in New York City has helped to produce substantial savings in the cost of producing power during each operating month as compared with the previous steam engine installation.

Prior to the installation of the Diesel generating unit, power was furnished for 20 hours per day by a 400 kw steam engine generator unit, and during the balance of the day small steam engine generating units of 75 and 125 kw carried the load. With this arrangement, opportunity for adequate maintenance of the large engine unit was extremely limited. Then, too, during the warm weather months when demand for exhaust steam was at a minimum, a large amount of steam was wasted.

The new Diesel unit is the perfect answer to both these problems, being available at any time as standby for the large steam unit and eliminating the waste of exhaust steam during the warm months when it runs continuously.

The Diesel is a 6 cylinder, four cycle engine having 16 in. bore and 20 in. stroke. The starting air is supplied at 250 psi by a Worthington two-stage compressor. Jacket water, raw water and waste heat boiler feed pumps were all supplied by Worthington.

Million Dollar Baby

Installation of Model C Worthington Allspeed Selectors, at The Floyd A. Holes Co. plant in Bedford, Ohio, finally brought a well-deserved lay-off to a Model A Allspeed Selector purchased during the early part of the war.

It was originally put to work on a laminating machine making Grade C Type I ordnance wrap. The machine was then equipped with a ¾ hp motor. For a long time, the equipment was operated as hard as possible—from high speed to low speed about every 1½ minutes for 24 hours a day, seven days a week.

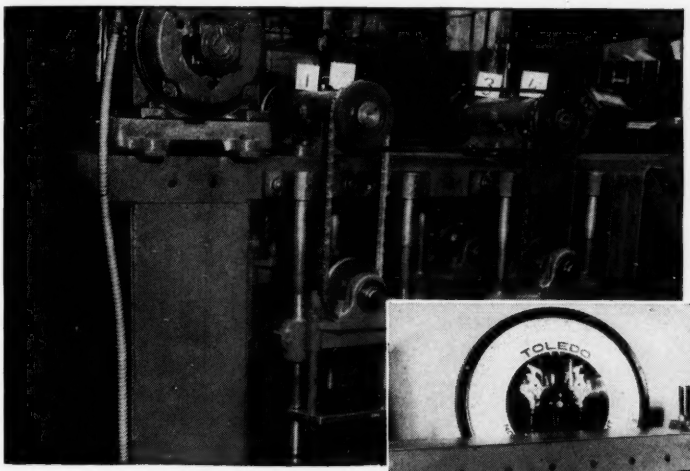
Then a 1 hp motor was installed—and later, a 2 hp motor. Finally, the drive—not intended for such heavy service—began to falter and was replaced with the larger Selector.

Mr. F. A. Holes reports:
"That little drive produced over a million dollars worth of Grade C Type I before we finally removed it from that operation. Since that time, we have placed it on several smaller operations, and we want you to know that it is still working perfectly today whenever we have occasion to use it. We believe that this is indeed a complimentary record for this piece of equipment and felt that you would like to know about it."

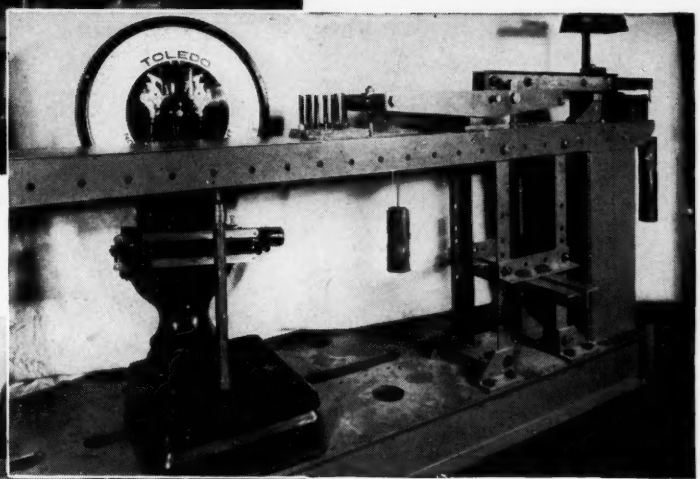
Worthington Pump and Machinery Corporation
Harrison, N. J.

NEWS

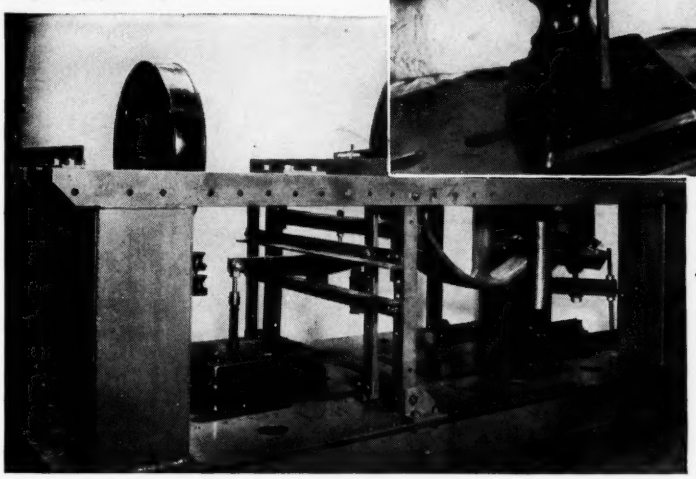
Universal Test Stand for Worthington Multi-V-Drives



Typical set-up of fixtures for comparative testing of Vee Belts to determine flex life and endurance under various speeds and loads. Photos taken in Worthington's Multi-V-Drive Research and Development Engineering Dept.



This fixture tests various kinds of steel and heat treatment on QD sheave hub pull-up bolts for wrench torque, elongation, elastic limit, ultimate strength and distortion in the thread lead relative to pulling power of bolt.



Static torque testing apparatus with rating up to 200,000 inch pounds torque determines cone grip capacity of QD sheaves and hubs. It permits mechanical or electric detection of cone slip in minute proportions.

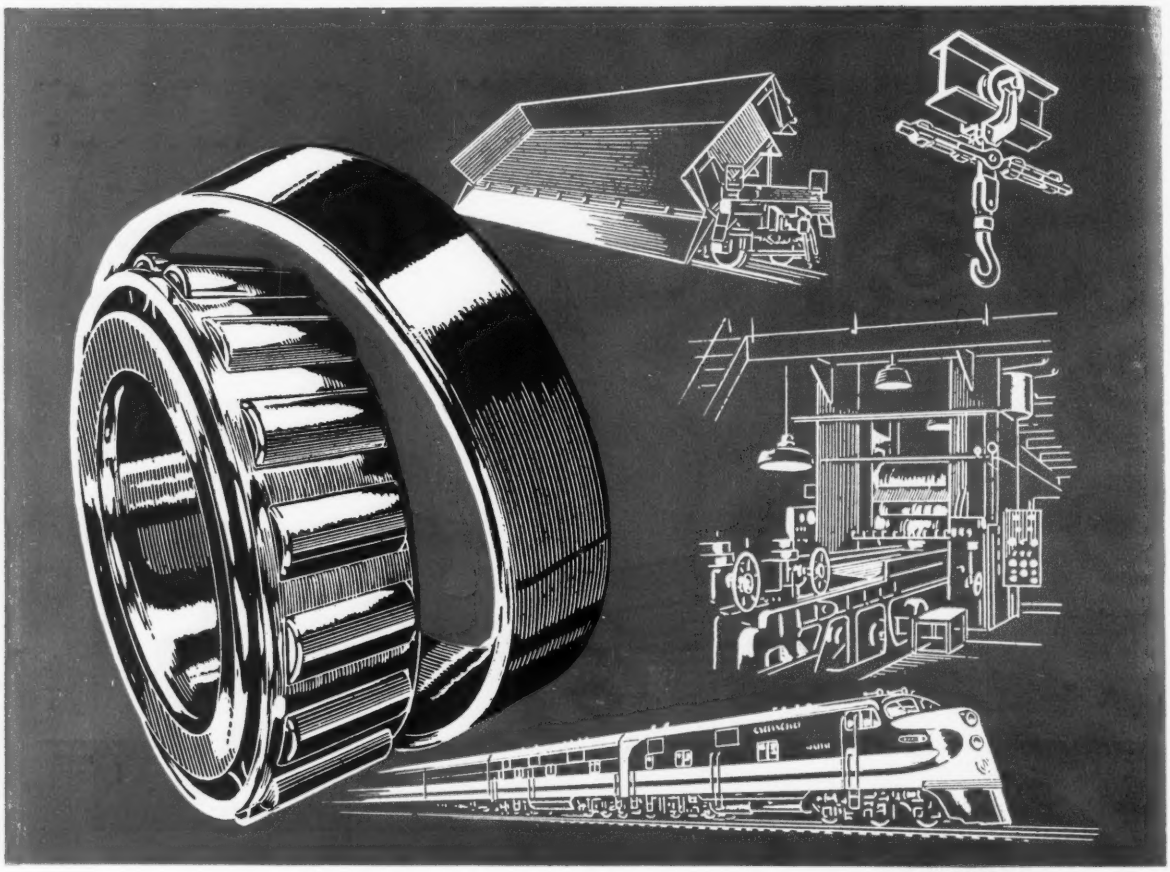
It's a Long Drink from Arkansas to Chicago

Mountain Valley Water Company supplies bottled water to thirsty Chicagoans, all the way from Hot Springs, Arkansas. Until this past summer, the water had been shipped in 30-gallon drums. Unloading these drums from freight cars at the Chicago end took four men about five hours per freight car load of 5500 gallons.

Last May two 8000-gallon tank cars were leased. When the water arrives in Chicago, the tank is hooked up with a Worthington Monobloc Centrifugal pump in the basement of the bottling plant, and within two hours, the water has all been transferred to stainless steel storage tanks on the fourth floor of the building. Labor cost involved is just for starting and stopping the pump motor.

The pump is 3 hp, 3600 rpm, with a 3-phase, 220/440 volt drip-proof motor.

YES! Tycol Acylkup Greases perform better . . . BETTER . . . BETTER



Tycol Acylkup Greases perform better because:

. . . *Tycol Acylkup Greases* are made from finest quality cylinder stocks and refined neutral oils, combined with a minimum of soap.

. . . *Tycol Acylkup Greases* are engineered to take it. They assure maximum performance.

. . . *Tycol Acylkup Greases* keep bearings smooth running and cool.

. . . *Tycol Acylkup Greases* supply the "film of protection" needed to give power a chance to produce.

Complete information on Tycol Acylkup Greases is available from your nearest Tide Water Associated Office. Write, wire, or phone today.

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Pittsburgh • Philadelphia
Chicago • Detroit • Tulsa
Cleveland • San Francisco

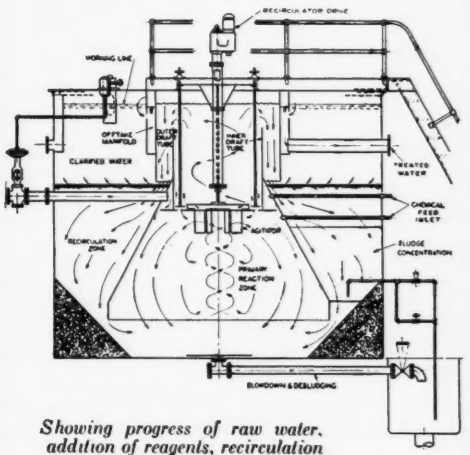
TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N.Y.

LUBRICATION—"ENGINEERED TO FIT THE JOB"

Announcing COCHRANE RAPID REACTORS

COMBINING the basic elements of equipment for mixing, floc formation, settling and thickening in a single reaction vessel, the Cochrane Rapid Reactor permits chemical reactions and separation of coagulated solids in only a fraction of the time necessary in intermittent cold process softeners. When the chemicals are added to incoming water, recirculated sludge seeds the precipitation and accelerates the chemical reactions.

COCHRANE RAPID REACTOR



Showing progress of raw water, addition of reagents, recirculation arrangements, and method of collection of clarified effluent.

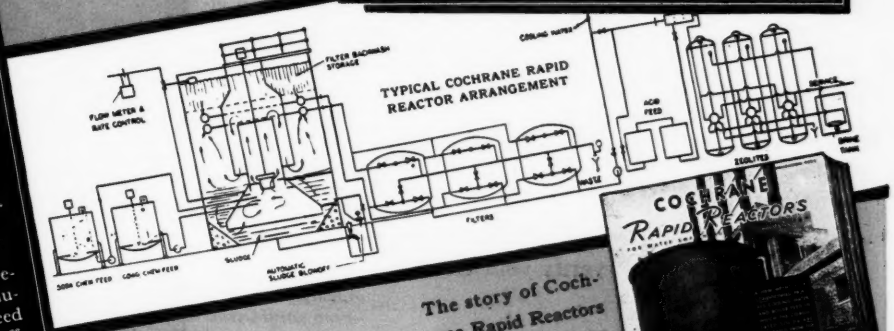
ADVANTAGES OF COCHRANE RAPID REACTORS

LOW FIRST COST
Simple compact design.

LOW OPERATING COST
More efficient utilization of chemicals.

MINIMUM SPACE REQUIREMENTS
Conservative in floor space and head room.

CONSISTENCY OF TREATMENT
Results from large recirculation volume, automatic chemical feed and sludge blowoff, and thorough mixing.



The story of Cochrane Rapid Reactors is told in Cochrane Publication No. 4425. A copy will be sent upon request. Coupon is for convenience.

COCHRANE

COCHRANE CORPORATION • 3123 N. 17th ST. • PHILADELPHIA 32, PA.

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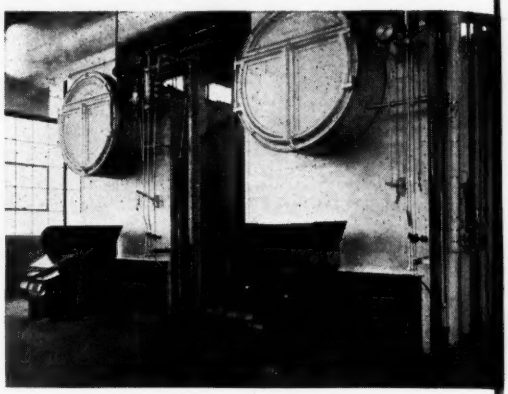
CHOOSE *YOUR* STOKER

from the experience

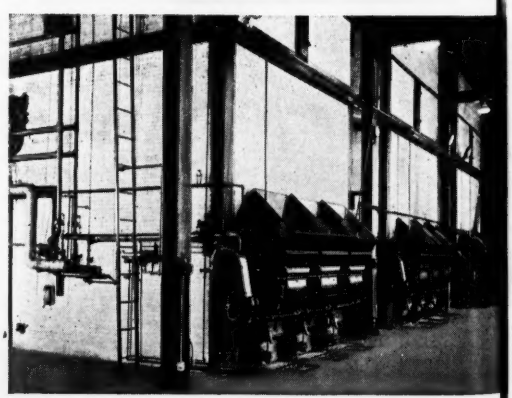


More than ever, with today's coal prices, getting the right stoker pays big dividends. And the choice of the right stoker for your steam load, boiler design and available fuel is greatly simplified when you turn to C-E for the answer. Why? Because 19,850 C-E stoker installations (above residence size) make available to you an accumulated experience unmatched by any other stoker manufacturer.

Coupled to this unparalleled experience is a *complete* line of stokers which includes *every* basic type, thus eliminating the possibility of bias in the recommendation C-E makes to you.

Out of these thousands of C-E installations, three stoker designs stand out as most suitable for today's needs . . . the Skelly and Type E (both single-retort underfeed types) and the Spreader Stoker. In fact, these three types have been applied in ninety out of every hundred C-E stoker installations made in recent years. Yet, if your requirements fall within the 10 per cent group, C-E offers you other designs which round out the most complete line of stokers available anywhere.

Check your needs against one of these three . . . then have a C-E engineer verify your choice. B-225



C-E

COMBUSTION

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS. ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

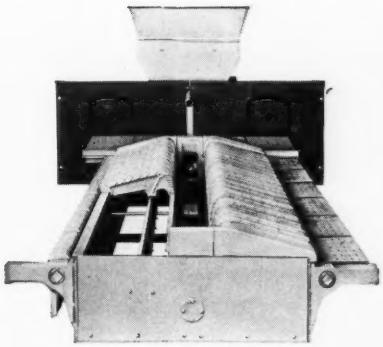
WITH CONFIDENCE

of thousands . . .

SKELLY STOKER UNIT

Approximate Application Range—20 to 200 boiler hp.

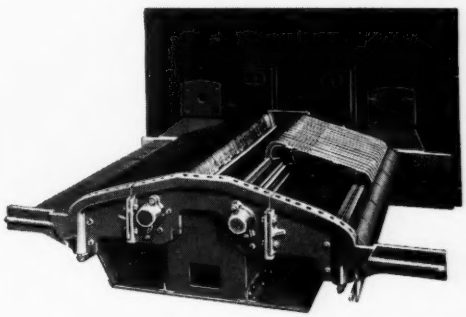
A compact, self-contained underfeed unit available in designs for burning either anthracite or bituminous coal. An alternate arrangement of fixed and moving grate bars assures lateral distribution of fuel and maintains a clean porous fire. Cantilever dump grates of non-avalanching type simplify ash removal. An integral forced-draft fan, with vortex inlet control, permits positive regulation of air-coal ratio. Sixteen rates of coal feed through variable-speed transmission. Automatic control is standard equipment. Timken bearing equipped. Alemite lubrication throughout.



TYPE E STOKER

Approximate Application Range—150 to 600 boiler hp.

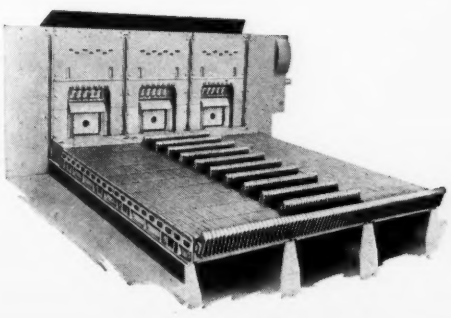
A single-retort, underfeed stoker designed to burn a wide variety of bituminous coals, particularly those having caking and coking characteristics. The Type E has ram type feed supplemented by a reciprocating sliding bottom. Its grate surface consists of hollow, air-cooled grate bars arranged in an alternately fixed and moving relationship to condition the fuel bed and assure its steady movement to the dump trays which are of the cantilever type. Air supply is under zoned control with provision for introduction of air over the fire. Type E Stokers are available with steam, electric or hydraulic drive.



SPREADER STOKER

Approximate Application Range—150 boiler hp. up to units producing 200,000 lb of steam per hr, or more.

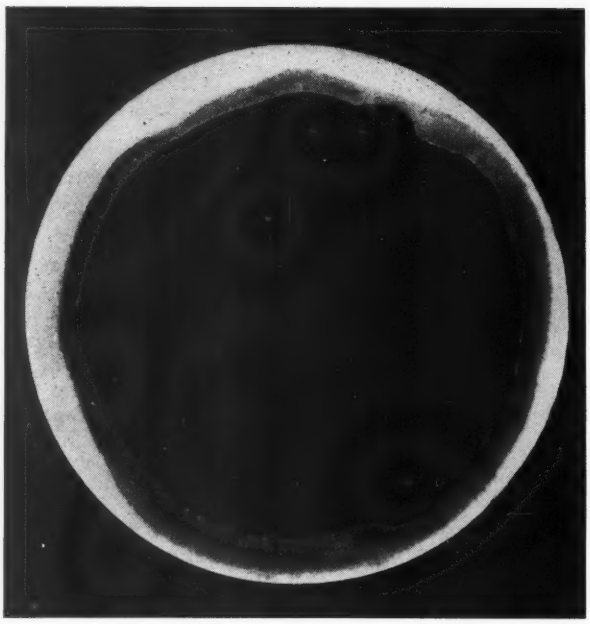
The C-E Spreader Stoker is available in both dumping grate and continuous discharge types. This simple, rugged stoker is designed to burn a wide variety of coals. Hopper, feeding and distributing mechanism, variable-speed drive and motor are combined in a compact unit. A series of rotating spreader blades feeds coal into the furnace in criss-crossing streams which assure uniform distribution. Fines are burned in suspension and the rest of the coal is burned on the grate. Grate surface is zoned for regulating air admission and to facilitate cleaning. All parts subject to wear are readily accessible for inspection, adjustment or replacement, when necessary. Rate of fuel feed and air supply may be regulated over a wide range and are readily adaptable to automatic control.

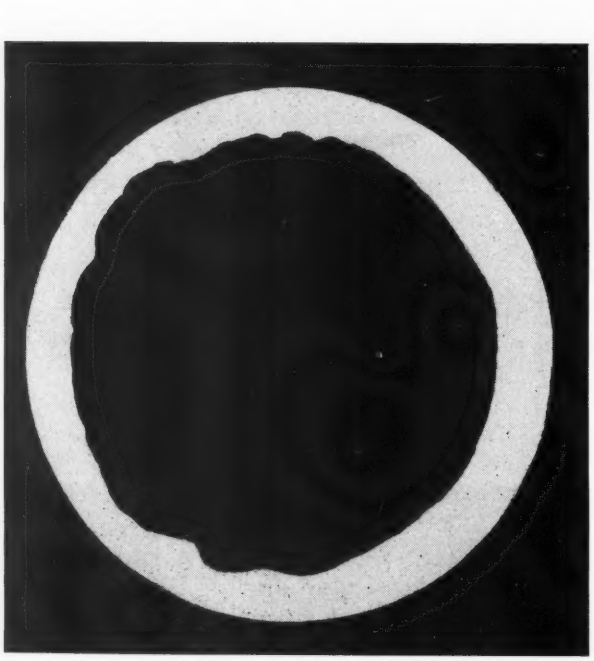


C-E ENGINEERING

200 MADISON AVENUE, NEW YORK 16, N. Y.

What Causes





THIS TUBE from a 1400-psi boiler has obviously suffered serious corrosion over most of its internal surface, but there is still lots of sound metal left—or is there?

Etched with acid, the cross-section tells the true story of its dangerously embrittled condition. Due to a subtle change in microstructure, the inner portion showing black in the cross-section is as brittle as cast iron. How much longer could it have withstood failure?

Although in some respects unlike the well-known embrittlement in riveted seams and

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Tube Embrittlement?

rolled tube ends, this damage to the heat-transfer surface of a tube stems from the same fundamental reaction between steel and boiler water. Like embrittlement in riveted seams, it is greatly accelerated by concentration of caustic in contact with the steel.

But how can caustic concentrate where there are no seams or crevices? Actually, concentration always *must* occur on the heat-transfer surface whenever a boiler water with a normal low content of caustic soda is being evaporated at a high rate in a boiler tube.

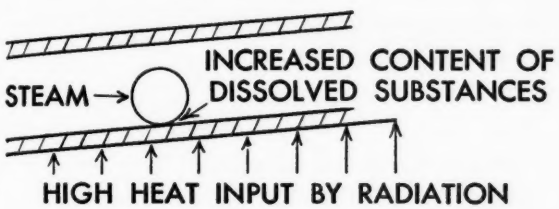


Fig. 1 shows schematically what happens when steam is generated. As heat transferred at a high rate from the metal causes the water to evaporate, whatever was dissolved in the water tends to be left in the residual film on the tube surface. Endless repetition of the process can build up and maintain a concentrating film in which caustic soda is present to the extent of several per cent, even without excessive overheating of the steel. The higher the rate of heat transfer in any region of the tube, the higher will be the caustic content of the film and the greater the tendency toward corrosion of the steel. In a few cases, the exceptional damage illustrated has been found.

Even the turbulent flow of dilute boiler water over the surface cannot wash away the concentrating film, constantly being regenerated by the very process of evaporation. Any coating of sludge or corrosion product protects the film against dilution and aids still further in maintaining the caustic at a level which can greatly accelerate corrosion and embrittlement of the type pictured above.

There is no panacea for tube embrittlement. Prescriptions for prevention must be based on a comprehensive knowledge of all factors that enter into the problem, and this knowledge must be utilized to set up the procedure which is most advantageous to the boiler owner. In this, as in all other problems related to industrial uses of water, Hall Laboratories is at your service.

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

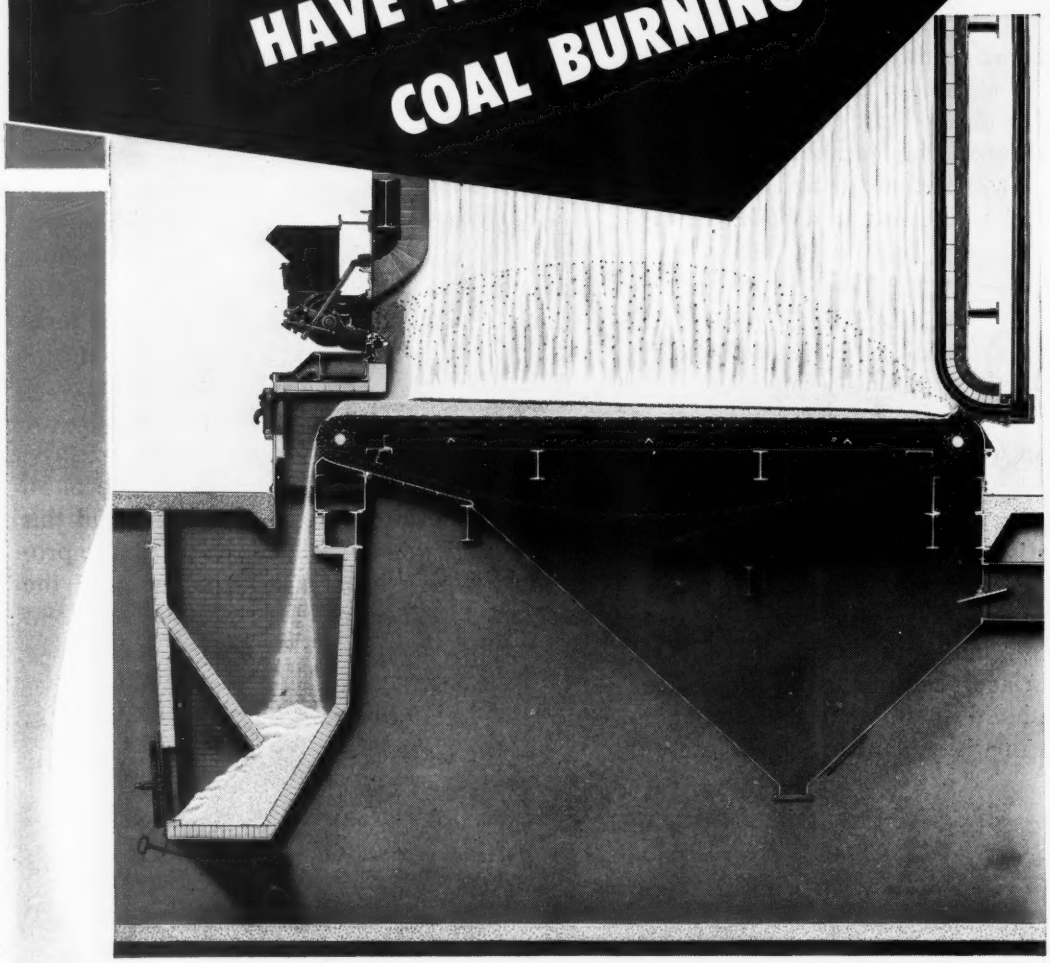
HALL LABORATORIES, INC.

(A Subsidiary of Hagan Corporation)

CONSULTANTS ON
INDUSTRIAL WATER TREATMENT
HALL SYSTEM OF BOILER WATER CONDITIONING
INDUSTRIAL WASTE RECOVERY AND DISPOSAL

In the Past 10 Years

DETROIT ROTOGRATE STOKERS HAVE REVOLUTIONIZED COAL BURNING

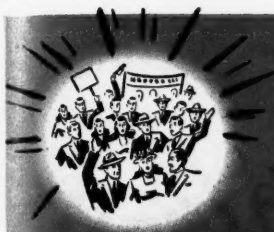


Grates move forward slowly and continuously, automatically regulated in proportion to the quantity of fuel being burned.

DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

WORKS AT MONROE, MICHIGAN • DISTRICT OFFICES IN PRINCIPAL CITIES



Elected by Popular Choice!

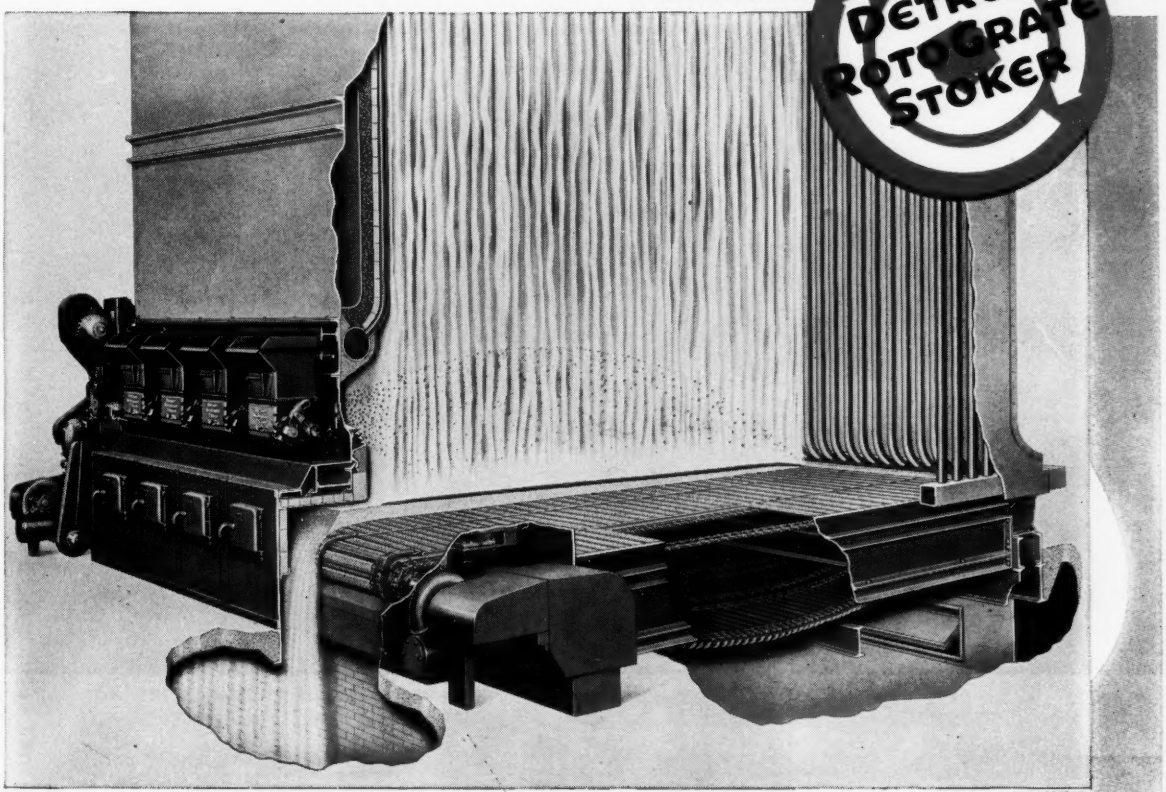
Several hundred Detroit RotoGrate Stokers are now installed or on order.

The successful record of the original forward moving, continuously cleaning spreader stoker.

Advantages Are:

- **Higher burning rates demanded by modern steam generators.**
- **Continuous operation for long periods.**
- **Operate with high CO_2. Preheated air may be used.**
- **Burn high or low grade coal or lignite.**
- **No clinker or slagging difficulties.**
- **Requires little power for operation.**

DETROIT ROTOGRATE STOKER



Detroit RotoGrate Stoker with six grate sections as applied to a typical water cooled furnace of a steam generator. Two of the six Rotors removed to show the overlapping grate design.

DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

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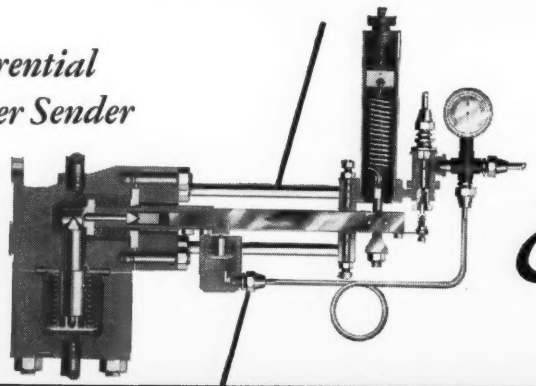
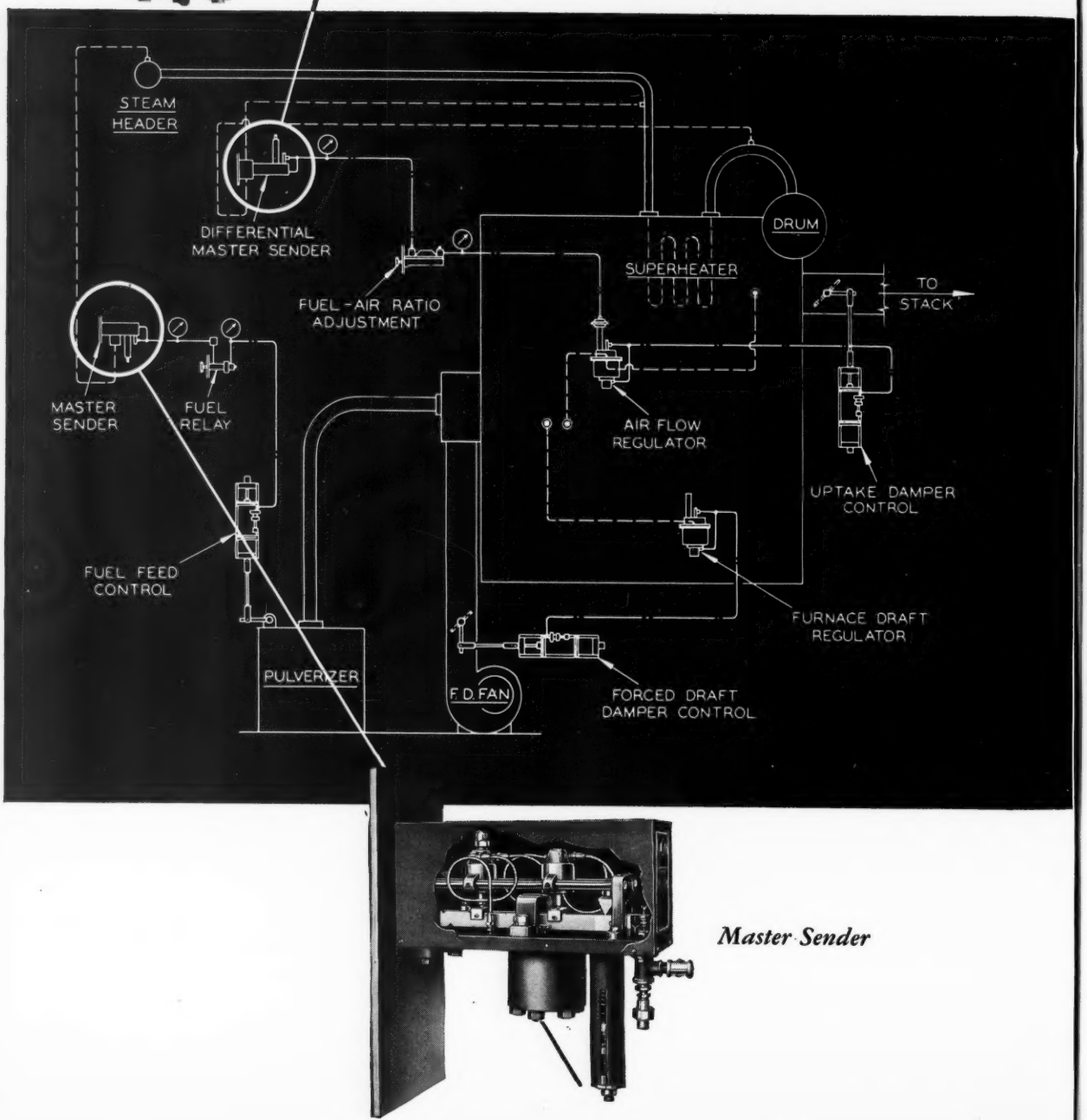
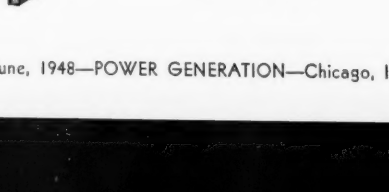
Differential Master Sender



simple...





Master Sender

direct... accurate

the Hagan Differential Master Method of automatic combustion control

IN THE firing of pulverized coal, the accurate maintenance of fuel-air ratio has been hampered by such factors as variation in the calorific value of coal, and variation in operation of coal feed mechanisms which are affected by moisture content and coal size.

The Hagan Differential Master method of combustion control automatically maintains proper combustion conditions in a simple and direct way, using the boiler unit itself as a calorimeter of heat input.

A Master Sender, sensitive to steam header pressure, controls the rate of fuel feed so that B.t.u. input is in accordance with demand.

A Differential Master Sender, measuring steam flow, regulates air flow.

These units are not interconnected; each has its own function, and performs that function *directly.* The rate of fuel feed is changed instantly to compensate for any change in steam demand, or variation in calorific value of fuel or in feeder characteristic. Air, however, is changed only when there is an actual change in steam flow.

Control is direct and accurate—there is no necessity for approximate adjustment, to be corrected by a lagging corrector system.

Tested in Service. The Differential Master method has been thoroughly tested in service. It has been applied to boilers burning oil, gas, and pulverized coal, and to multiple fuel boilers. Boiler sizes ranged from 30,000 lbs./hr. at 200 p.s.i. to 900,000 lbs./hr. at 1800 p.s.i. In every instance, results have been entirely satisfactory.

Substantial Fuel Savings. Where the differential master sender can be applied, it gives better control of combustion and substantial savings in fuel. Our engineers will be glad to discuss its possibilities in your plant. Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

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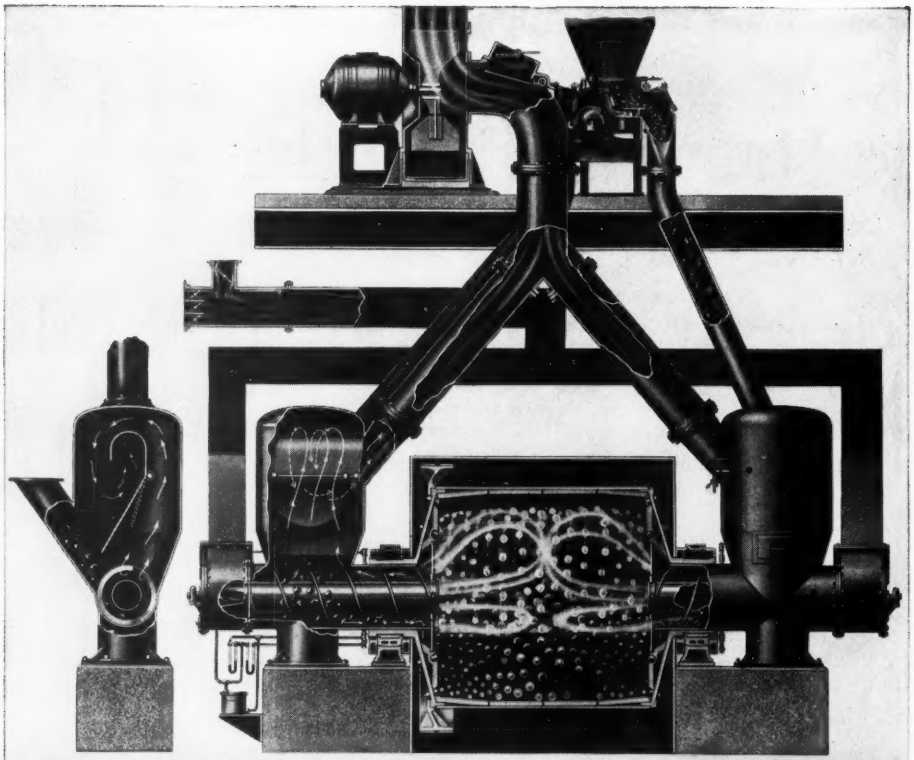
BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
THRUSTORQ FORCE MEASURING DEVICES

The FW Ball Mill provides



Sectional view of the FW ball mill pulverizer. The ball mill provides one of the most effective methods of pulverizing hard or abrasive fuels. This ball mill pulverizer, developed by FW, incorporates a high degree of efficiency, availability, and economical operation.

Outstanding Features

1. **Large Reserve Capacity**
2. **High Availability – Low Maintenance**
3. **Constant Fineness**
4. **Successful Installations for Pulverizing**
   - **a. Anthracite Coal**
   - **b. Bituminous Coal**
   - **c. Coke Breeze**
   - **d. Lignite**
   - **e. Petroleum Coke**
5. **Systems with All Component Parts**
6. **50 Years Background**

high availability — low maintenance

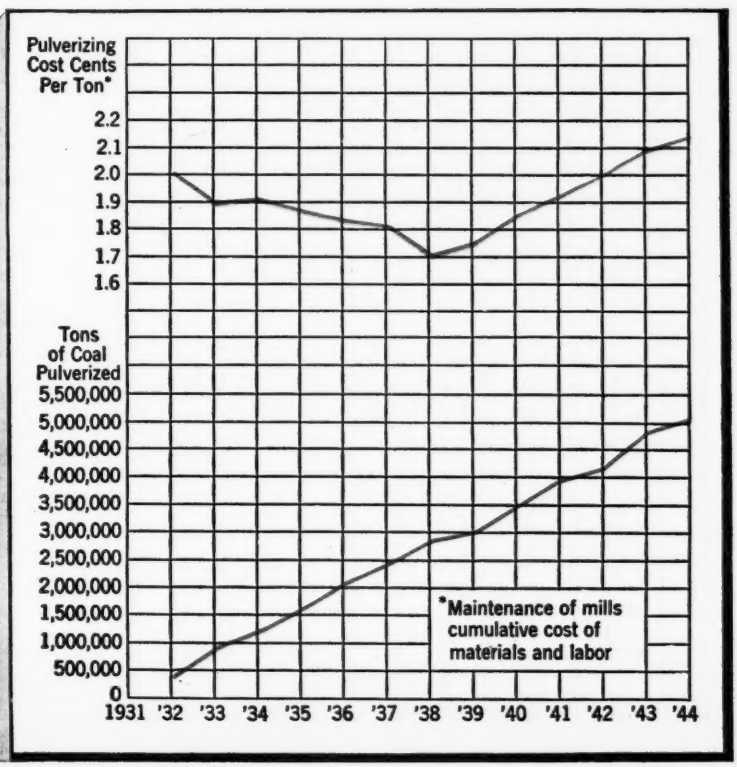
2

High availability and low maintenance are assured where Foster Wheeler ball mill pulverizers are used. Operating records of FW ball mills consistently show a remarkable availability of 99% or better. With this high availability the use of multiple pulverizers for each boiler is unnecessary.

The pulverizing elements are plain forged steel balls which are added with the coal feed as required, without interrupting plant operation.

FOSTER WHEELER CORPORATION, 165 BROADWAY, NEW YORK 6, N. Y.

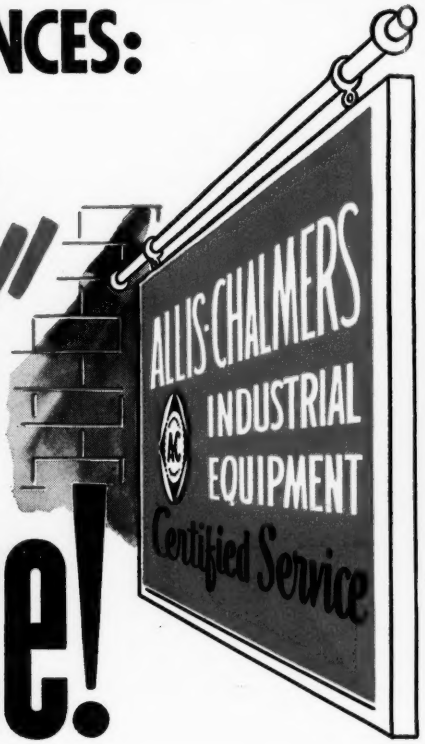
FOSTER WHEELER



* Thirteen year record of 9 FW ball mill pulverizers showing graphically that mill maintenance costs remained virtually unaffected. Note that mill maintenance costs follow the trend of material and labor costs, and not length of service.

ALLIS-CHALMERS ANNOUNCES:

"Certified" Motor Service!



Independent Local Shops of High Standing Are Now Being Selected to Service and Repair Allis-Chalmers Motors—Transformers—Controls—Pumps—on a Certified Basis!

THE NAME "ALLIS-CHALMERS" has always meant good motors, generously built for long life! Now you have an *added* reason for investing in Allis-Chalmers motors . . .

BETTER SERVICE

Throughout the U. S. qualified motor repair shops are being selected and authorized as Allis-Chalmers *"Certified"* Service Shops. Each will have trained personnel as well as complete facilities for servicing and repairing Allis-Chalmers motors to original factory-established standards!

"CERTIFIED" Service Benefits You These Ways:

YOU GET FINEST PARTS. *"Certified"* Service Shops use genuine Allis-Chalmers repair parts — or parts of equal quality! Each shop is given complete service information, including factory procedure and drawings, if necessary. Result: factory-like workmanship!

YOU GET FINEST SERVICE. Every Allis-Chalmers *"Certified"* Service Shop has been selected on the basis of its excellent reputation in the community. It's the kind of shop you *like* to do business with!

How To Get Allis-Chalmers "CERTIFIED" Service:

Right now most Allis-Chalmers *"Certified"* Service Shops are located in the larger U.S. industrial areas. But they're rapidly expanding. For service, call your nearby A-C District Office, or Authorized Dealer. If we do not have a Service Shop in your locality, we will recommend the one closest to you. ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN. A 2457

"Headquarters" for Motors ½ to 25,000 hp and Over!

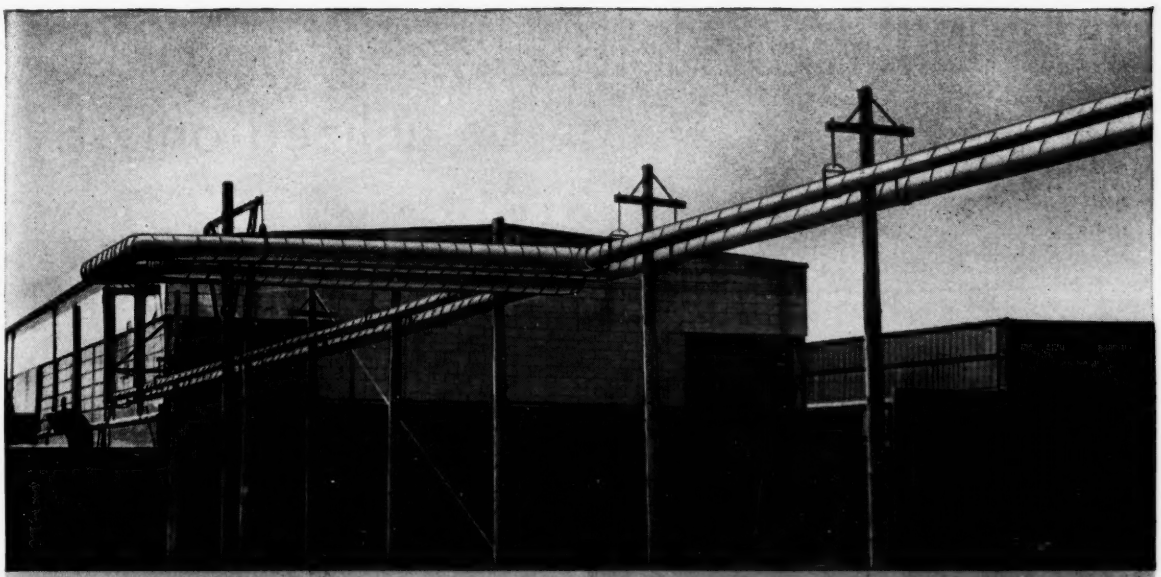
Do You Need Standard, squirrel-cage motors from 1 to 200 hp? Your nearby "A-C" authorized dealer or district office may be able to help you — immediately from stock.

For big motors, 250 to 25,000 hp and up, call your "A-C" field engineer. He's an expert on motor application —can help you solve drive problems involving large or small motors.

The big question today is "How Fast Can You Deliver?" Allis-Chalmers representatives in over 60 District Offices—over 200 Authorized Dealers — have *up-to-the-minute* delivery schedules available to them. Call either of these sources next time you need good motors.

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products



RIC-WIL *Foilclad* PIPE UNITS

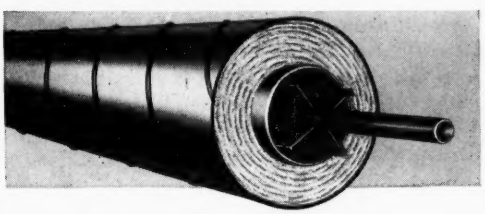
Combine Efficiency and Durability with Low Cost Installation and Maintenance

Factory prefabricated, insulated and weatherproofed, Ric-wiL Foilclad Pipe Units are especially designed for pipe distribution systems carrying oil and other viscous fluids, process liquids, refrigerants, steam or water.

Custom built to project specifications, Foilclad Units, in 21 ft, lengths, complete with odd lengths, couplings, and accessories as required, are delivered ready for immediate *single-handling* installation on arrival. The Ric-wiL Unit system reduces to a minimum the costly, tedious and frequently dangerous field work often involved in other types of piping installations.

Foilclad Units are designed so that field welding of pipe is a quick and easy operation. Several units at a time may be coupled on the ground before hoisting into position, eliminating a considerable amount of scaffolding.

More important, the Ric-wiL method of factory prefabrication and insulation—*exclusive with Ric-wiL*—assures a pre-tested, dependable, permanent system that eliminates ordinary maintenance and repair expense otherwise frequently required.



The insulated, jacketed pipe unit, above, is designed so that any required temperature can be maintained in transmitting fluids. Either pipe can be used to carry the process liquid while the other carries the heating or cooling medium, gas or liquid.

The outer pipe is covered with laminated asbestos insulation—or other type insulation as required—in any thickness desired. Insulation is machine coated with high temperature asphalt and tension-wrapped with asbestos felt, followed by second coating of asphalt. The final covering is a spiral tension wrapping of aluminum or copper foil bonded with the asphalt coating. The result is a rugged and durable unit, corrosion resistant and fully weatherproofed.

Write for Form 4708, for additional information on Foilclad and other Ric-wiL Units. Address The Ric-wiL Company, Cleveland, Ohio, Dept. 786

RIC-WIL

INSULATED PIPE CONDUIT SYSTEMS

THE RIC-WIL COMPANY • CLEVELAND, OHIO

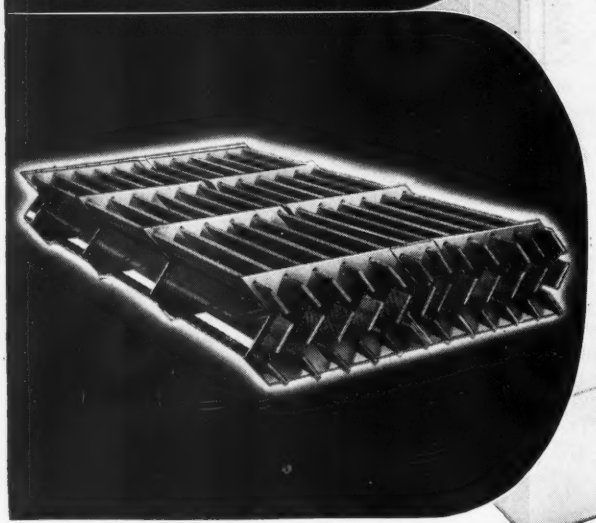
CABLE ADDRESS: RICWIL, BENTLEY'S CODE

Maximum WETTED SURFACE

can be utilized only by

Double-Flow

COOLING TOWERS



How much filling (primary wetted surface) should a cooling tower contain? Enough to thoroughly break up the water into small drops and retard its flow, thus keeping water in contact with air stream for maximum evaporation. The limiting factor is that filling impedes air flow.

Only Marley Double-Flow towers convert this limitation to a distinct operating advantage. Only in Double-Flows can filling be positioned horizontally, as it must be for good break-up and water retardation, yet present the narrow edge of strips to the air stream. The horizontal air stream (exclusively Double-Flow) meets only this edge, then passes across the two widest faces of each strip, thus combining greatest break-up and retardation with desired evaporation.

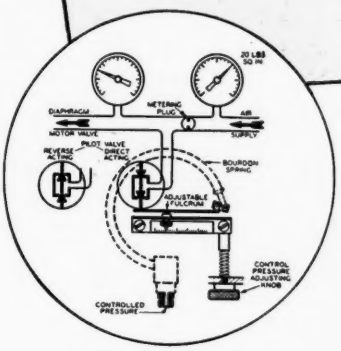
Marley Nail-less Filling is designed to retain perfect alignment. Rigidly supported at close intervals, it is not permanently fastened at any point. It is free to expand and contract as temperature changes dictate. It cannot warp, twist or sag, allowing solid streams of water to flow through the center of filling sections, leaving the ends dry and inoperative.

In Double-Flows the Triple-Effect Drift Eliminators are positioned to give greater area for air passage than is possible in any other type tower. This also helps overcome the limit to efficient use of filling. Like the filling, Marley eliminators are of nail-less, sagless, long-life design.

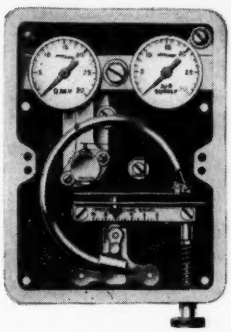
MARLEY COOLING TOWERS

THE MARLEY COMPANY, INC. • KANSAS CITY 15, KANSAS

MORE ACCURATE PRESSURE CONTROL



Schematic diagram and internal view of Series 46 Kontrol Master Pilot



VACUUM TO 10,000 LB.

REDUCING OR BACK-PRESSURE

CLOSE-COUPLED OR REMOTE

TYPES

46-V—Valve mounted, side connected
46-S—Panel or wall mounted, side connected
46-B—Panel or wall mounted, back connected

PRESSURE RANGES

(BRONZE TUBE)

0-30 lb.	0-200 lb.
0-60 lb.	0-300 lb.
0-100 lb.	0-600 lb.
0-1000 lb.	

(STEEL TUBE)

0-30 lb.	0-300 lb.	0-2000 lb.
0-60 lb.	0-600 lb.	0-3000 lb.
0-100 lb.	0-1000 lb.	0-5000 lb.
0-200 lb.	0-1500 lb.	0-10,000 lb.

Write for 100-page catalog "Automatic Equipment for Pressure and Level Control."

Vernier adjusting screw—either inside or outside the weather-proof, gas-tight case—enables Kontrol Master Pressure Pilots to adjust to unusually fine pressure settings.

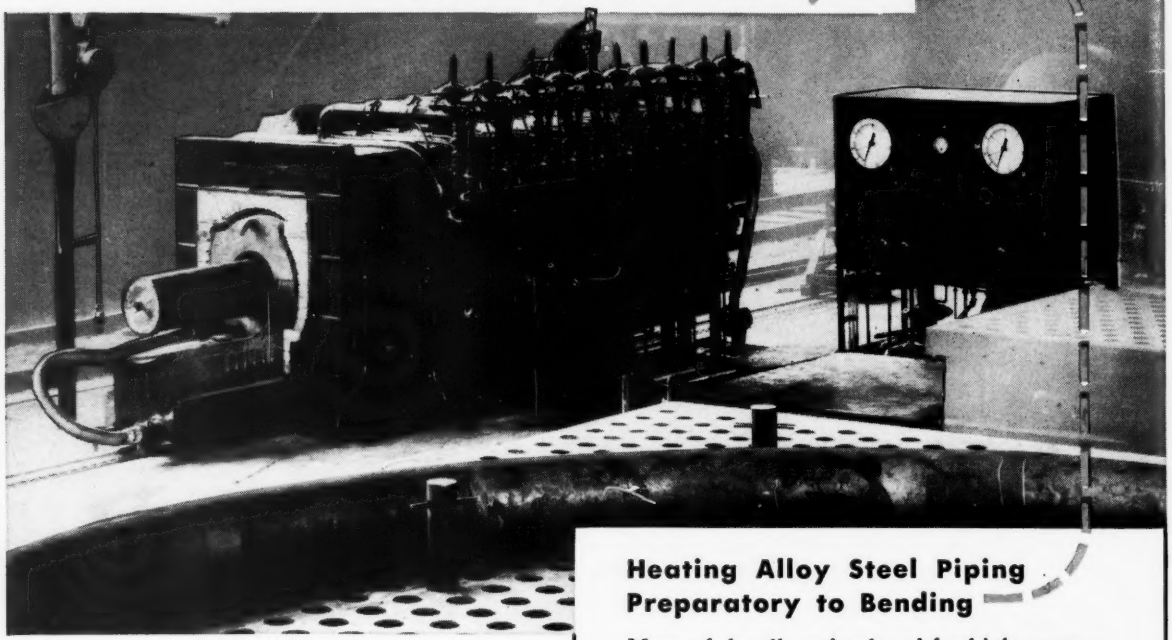
Used with K&M Kontrol Motor Diaphragm Valves, Kontrol Master Pilots can be mounted right on the valve or, if more convenient, on a remote panel or wall. Air supply and controlled pressure connections can be at back or through side of case, as requirements dictate.

Many features of more expensive instrument-type controllers are offered in this accurate and versatile unit. Throttling range is easily adjusted by means of a thumb screw. Variations in proportional band of from 1% to 75% of the pilot pressure range can be quickly effected by merely sliding the thumb screw along its slot. Changes from direct to reverse action (or vice versa) are made in less than a minute—without disturbing bourdon tube or nozzle block.

If sensitive and flexible pressure control is important in your process, it will pay you to get full details on Kontrol Master pneumatically operated pressure pilots. Kieley & Mueller, Inc., North Bergen, N. J.

KONTROL KIELEY & MUELLER MASTER
NORTH BERGEN, N. J.

IF THERE EVER WAS A JOB FOR SPECIALISTS— *THIS IS IT!*



Heating Alloy Steel Piping Preparatory to Bending

Many of the alloys developed for high-pressure, high-temperature services and for corrosion-resistant applications are susceptible to loss of their valuable properties within certain temperature ranges as a result of excessive changes in metallurgical structure, surface oxidation, heat shock and cracking.

Only furnaces equipped to maintain accurately the specified temperature of the pipe are capable of retaining and safeguarding the metallurgical properties which dictate the choice of material.

Grinnell's modern pipe fabrication equipment includes specially designed gas-fired *radiant heat* furnaces, with such features as strategic location of multiple burners providing uniform temperature distribution and preventing harmful flame impingement, close temperature and time controls, automatic regulation, recording instrumentation and car loading.

Prefabricated Piping from GRINNELL assures you *QUALITY*

Grinnell interpretive engineering, metallurgical research, specialized facilities, skilled personnel and rigid inspection, assure delivery of pretested and certified piping sub-assemblies which meet all governing code requirements.

Prefabricated Piping from GRINNELL assures you *ECONOMY*

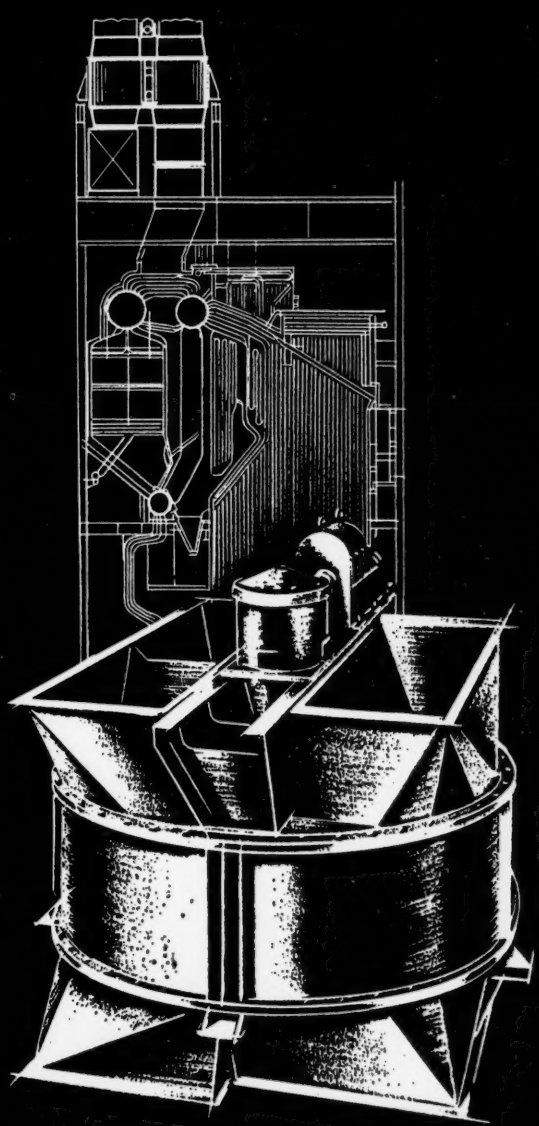
One source for design and fabrication. Coordination of shop production under ideal conditions. Predetermined but flexible delivery schedules. Elimination of waste by paying only for finished assemblies. Reduction in field assembly time.

GRINNELL COMPANY, INC. Providence 1, R. I.
Branch warehouses in principal cities.
Pipe Fabrication Plants: Cranston, R. I.; Warren, Ohio.

GRINNELL
WHENEVER **PIPING** IS INVOLVED

Designed for Preheat

where fuel is a problem



The Ljungstrom Air Preheater simplifies the problem of burning such fuel as oil, low-grade coal, bagasse or paper-mill refuse.

While plans for steam generation plants are under consideration, investigate the possibilities of the Ljungstrom. The specialized experience of Air Preheater engineers is at your disposal, to aid in effecting the most economic heat recovery from flue gases.

The Air Preheater Corporation

EXECUTIVE OFFICES: 60 East 42nd Street, New York 17, N. Y. • **PLANT:** Wellsville, N. Y.

In All Industries

NALCO WATER TREATMENT USERS TESTIFY TO CONTINUOUSLY SUCCESSFUL RESULTS

Scale and Corrosion Control
Algae, Slime and Bacteria Control
Water Softening
Water Purification
Waste Reclamation
for
Power Plants
Paper Mills
Refrigeration Plants
Chemical Process Plants
Food Processors
Railroads
Steel Mills
Metal-Working Plants
Municipalities
Refineries

THE ability of the Nalco System to provide continuously successful industrial water treatment under changing conditions, and in the widest imaginable variety of applications, is best proved by plants that use Nalco Service and Nalco chemicals year after year.

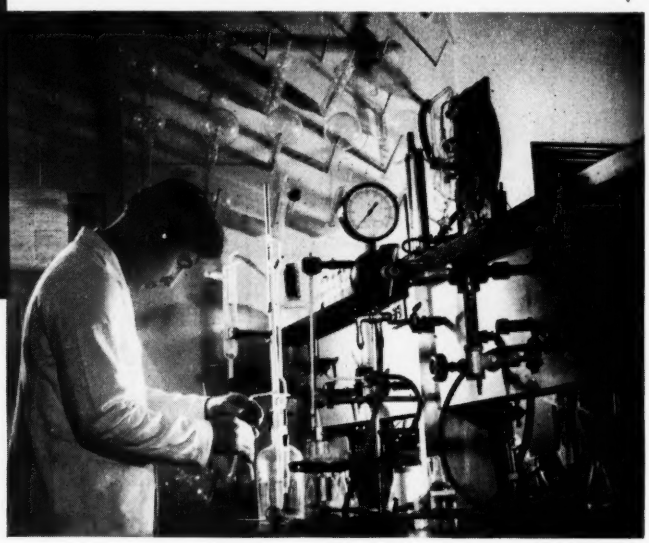
72.4% of all Nalco users have employed the Nalco System for *over 5 years;*

42% have been Nalco users *over 10 years,* and

25.3% of the over-10-year group have continued to get Nalco savings for more than 15 years.

Most of these plants had tried some other way to meet their water treatment problems before they discovered Nalco—the *permanent* answer. They are now getting the benefit of the world's finest water treatment laboratories, trained field engineers, continuous check-ups on their water conditions, scientifically prepared chemicals and specially developed chemical feeding and test equipment.

You can be sure of similar benefits if you call on Nalco. Write for details today.



Nalco

—the scientific system of water treatment

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place, Chicago 38, Illinois
Canadian inquiries should be addressed to
Alchem Limited, 555 Eastern Avenue, Toronto 8, Ontario

HELPFUL BULLETINS

BOILERS, ACCESSORIES

1 **Fuel Oil Conditioning**—A 7 page bulletin discusses the five main problems encountered in the burning of industrial fuel oil. Text, table and illustration all strive to explain the importance of several points in the treatment of fuel oil. E. F. Drew & Co., Inc.

2 **Self-Contained Fire Tube Boiler**—Bulletin SB-21-2M, 8 pages, describes and lists the rating and dimensions of the self contained boilers made by this firm. Cutaway, and under construction photos show important points. Actual applications in plants are shown for emphasis. Erie City Iron Works.

3 **Deaerating Feedwater Heaters**—Bulletin N-16, 8 pages, describes and illustrates a new spray-tray heater. Pointed out specifically is the fact that unit has no vent condenser. Sketches and line drawings illustrate the text. Elliott Co.

4 **Steam Accessories**—Bulletin 100 is a 4 page fold out sheet that depicts a complete high pressure power plant in several colors and shows where the many steam accessories made by this firm fit into the scheme of producing and utilizing high pressure steam. Schutte & Koerting Co.

5 **Refractory Brick Application**—A single page bulletin showing the application of this firm's refractory brick to a water gas set generator. Norton Co.

6 **Self-Contained Fire Tube Boiler**—Bulletin EC-64, an 8 page folder explains and illustrates the way various methods of firing the boiler may be done. Features of construction and flow charts are shown. C. H. Dutton Co.

7 **Combustion Safeguard**—Bulletin F1-1, 12 pages, contains illustrations, wiring diagrams, and descriptions of combustion safeguard systems. Construction drawings show important points. Wheelco Instruments Co.

VALVES, TRAPS, REGULATORS

8 **Steam and Water Mixer**—A catalog sheet, No. 900, describes the construction and operation of the Type SWV steam and water mixer made by this firm. Cutaway drawings illustrate construction and installation is shown in sketches. Capacities, dimensions, and list prices of spare parts are given. Sarco Co., Inc.

9 **Forged Steel 600 lb Valves**—Catalog 48FS, 16 pages, describes and illustrates this line of valves with line drawings, tables of working pressures, and cutaway drawings. List prices and dimensions are given. Valves include: Gate valves, outside screw and yoke, union or bolted bonnet; Globe and angle valves, inside or outside screw with either bonnet; Check valves, union or bolted cap. Ohio Injector Co.

10 **Pump and Check Valves**—This is a 4 page bulletin on the pump, hydraulic, and silent check valves made by this firm. The valves are illustrated. Working pressures, styles, assemblies, and special feaures are given. Combination Pump Valve Co.

11 **Ball Type Valves**—Bulletin V4-10M, 4 pages, illustrates with cutaway and equipment drawings the construction of this ball type valve in sizes from ½ to 2 in. Special features of materials and control are described. Dimensions for each size are given. Rockwood Sprinkler Co.

12 **Temperature Limiting Regulator** — This 4 page bulletin, No: 8531, explains and then describes the construction, operation and applications suitable for this snap action temperature regulator. Specifications, range, and dimensions are given. Manning, Maxwell & Moore, Inc.

13 **Industrial Thermostatic Steam Traps** —Bulletin No. 1047, 12 pages, is really a catalog containing descriptions, lists of applications, prices, and capacities. Drawings illustrate typical applications and recommended piping diagrams. A selection table is provided for choosing the proper size trap considering capacity factors. W. H. Nicholson & Co.

PUMPS

14 **Close Coupled Centrifugal Pumps**—Bulletin 710, 12 pages, is a catalog on the close coupled single stage type enclosed impeller centrifugal pumps made by this firm. Materials of construction, specifications, and performance curves for various sizes are given. Goulds Pumps, Inc.

GASKETS, PACKING

15 **Application of Leather Packings**—A helpful book of 52 pages that explain how mechanical leather packings are designed and how they should be selected for application. Photos, cutaway drawings, and dimensional drawings are used to increase understanding. Tables are given for each type. American Leather Belting Association.

16 **Chemically Inert Gaskets**—Four pages make up this bulletin on gaskets suitable for use around solvents and acids. The construction of 9 different types is illustrated with drawings to explain the various applications. United States Gasket Co.

MECHANICAL POWER TRANSMISSION

17 **Variable Speed Sheaves**—Four page Form No. 47-810 explains the construction and operation and possible applications in industry of this variable speed sheave. Application photos show the uses to which it may be put. DoAll Co.

ELECTRICAL

18 **Electrical Splicing Tape**—Bulletin No. 25, 8 pages, lists the properties, applications and methods of use for pressure sensitive electrical tapes employing the brand resins of this firm. Charts, sketches, and application photos illustrate points. Bakelite Corp.

19 **Electronic Voltage Regulators** — This 20 page catalog describes electronic control of voltages and currents and outlines the claimed advantages in providing adjustable output voltage, more precise regulation accuracies, good wave form, fast recovery time, and insensitivity to line frequency fluctuations. Sorensen & Co., Inc.

20 **Emergency Power**—Bulletin 4-1, 14 pages, is given to showing with photos and text the many applications to which emergency power generating units may be put. D. W. Onan & Sons, Inc.

21 **Multi-Circuit Unit Substations** — This 16 page bulletin, No. 11B6935, describes construction details of three transformer types, oil-filled, liquid-filled, and dry type. Featured are highlights of the load ratio equipment and the metal-clad switchgear. Allis-Chalmers Mfg. Co.

22 **Renewable Electric Fuses**—A catalog sheet describing 250 and 600 v fuses available in ferrule, knife, and plug types. Specifications, dimensions, and prices for capacities are given as an explanation of construction. Star Fuse Co., Inc.

23 **Electrical Relay Guide**—This guide is made up of 4 pages and deals with 24 different relays made by this firm. A full page indexed table lists all the specifications and dimensions plus additional features worthy of noting. Allied Control Co.

24 **Building Wires, Cables and Cords**—This 42 page bulletin contains detailed information on building wires, cable assemblies, and portable cords. Complete specifications are shown and pertinent code tables are included. Application and construction photos are used for illustration in addition to equipment photos. Appliance and Merchandise Dept., General Electric Co.

MATERIALS HANDLING

25 **Magnetic Separator**—Bulletin 801 contains factual information on how to remove tramp iron non-electrically from heavy loose flowing materials. The general use of the product, its magnetic strength, construction and advantages are also given. Illustrations show typical installations. Eriez Mfg. Co.

26 **Electric Monorail Hoists**—Bulletin 801-A, 8 pages, is a description of the type F hoists made by this firm. The construction and assembly of the hoists is depicted and the important points highlighted. Ratings of the hoists are listed. Dimensions for each type are given. Robbins & Meyers, Inc.

INSTRUMENTS

27 **4 in 1 Megohmer**—Bulletin No. 441, 4 pages, describes and illustrates the instrument that is an insulation tester, an ohmmeter, an a c voltmeter, and d c voltmeter. Instructions for use in application are given as are the specifications. Herman H. Sticht Co., Inc.

28 **Electrical Test Instruments**—This 54 page catalog, tab indexed, contains price lists and descriptive application stories in addition to instructions for use of the instruments. All the specifications are given as well as capacities. Associated Research, Inc.

29 **Instrument Transformers**—This buyer's guide of 80 pages supplies pertinent information and data, including prices, on all standard types of current transformers, potential transformers, and metering outfits, that conform to ASA insulation standards. Dimensions are not given but will be furnished on request. General Electric Co.

30 **Industrial Instruments**—This Catalog, No. L, is the general catalog for this maker of a wide variety of instruments. It is profusely illustrated with line drawings, applications photos, equipment photos, charts, tables, and complete specification lists for all the equipment made. Prices are given. General Radio Co.

PROPERTY MAINTENANCE

31 **Pressure Leak Sealers**—This 4 page folder describes and illustrates the applications and methods used for the two products recommended by this firm for sealing masonry or concrete walls retaining liquids. Engineering service is also offered. Sika Chemical Corp.

JUNE, 1948

POWER GENERATION

53 W. Jackson Blvd.

Chicago 4, Illinois

Please have the manufacturers send me without obligation the literature indicated by the number:

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32 **Interior Wire Barriers**—This is a catalog sheet depicting the construction and possible utilization of the woven wire barriers made by this firm for use inside the plant. Standard Wire & Steel Works.

33 **Protective Coating**—This 4 page bulletin illustrates and highlights the advantages claimed for this acid proof coating and shows applications in various industries. Listed are some of the acids that it will resist. Methods of application are given. Prufcoat Laboratories, Inc.

34 **Fabric for Roofs, Insulation**—This 8 page folder describes the waterproofing membrane fabric made with a base of glass. Application photos depict the use of this fabric when impregnated with mastic for roofing, pipe insulation, and other uses. Lexington Supply Co.

35 **Protective Paints**—This 28 page pocket booklet describes and explains the specifications and possible applications of the line of paints made by this company. These include oil base, bituminous base, aluminum base and varnishes. Quigley Co., Inc.

36 **Steel Deck Gratings**—Form 44 is a 24 page bulletin depicting the products of this firm in the many applications to which it may be applied. Discussion of construction, safety factor, type of finish, and specifications are given. Anchors for the grating are also described with photos and drawings to show application. A safe load table is given. Wm. F. Klemp Co.

37 **Rust Preventative**—A 36 page catalog, Form 246, contains instructions, cautions, and advice on application of the rust preventative made by this company. Specifications of each product are also given with most likely applications. Masonry and floor paints and finishes are also given in this manner. Rust-Oleum Corp.

38 **Isolating Vibration**—Bulletin Vc-500, 4 pages, is a handy bulletin showing the way in which vibration may be isolated by the use of cork. Depicted in 14 different drawings are the applications to which it may be applied. Listed are the proper loadings for different densities of cork. Korfund Co., Inc.

39 **Steam Detergent Cleaning**—Form 7238, 8 pages, explains where and how to use this type of cleansing and also the use of the solution and steam gun for paint stripping. The bulletin explains the different solutions and their use. Installation of fittings on plant steam lines is shown. Data sheet gives information on the solution-lifting steam gun. Oakite Products, Inc.

40 **Cleaning by Vacuum**—Bulletin No. 144, 20 pages, is a running story of the many uses which vacuum cleaning finds in industry. An important point often overlooked is the possible use of a vacuum system for reclaiming valuable materials. Spencer Turbine Co.

41 **Floor and Deck Gratings**—This 16 page bulletin presents the safety gratings made by this firm. The various important points of construction are shown with sketches and photos. Applications in various industries is shown. Standard sizes, safe loads, and specifications for sizes are given. Dominion Bridge Co., Ltd.

PROPERTY PROTECTION

42 **Whistles and Signals**—Bulletin 466, 12 pages, describes the design and operation of the whistles and signals and their controls that are made by this company. Installation and maintenance of these call devices are discussed separately and in step-by-step procedure. Selection of the device is dealt with by use of tables and charts. Leslie Co.

43 **Use of Proper Fire Extinguisher**—A 2 color, 2 page, folder lists the classes of fires, the type of extinguisher to be used for each class of fire, and explains the method of operating. Chart is illustrated with each type of extinguisher made by this company. General Pacific Corp.

44 **Fire Alarm Protection**—This is an 8 page bulletin on the fire alarm systems, boxes, signals, printing recorders, and punch registers made by this firm. All are illustrated and explained and modifications possible noted. Autocall Co.

EXHAUST SYSTEMS

45 **Fan Dust Collecting Systems**—This is a 32 page bulletin that depicts how the products made by this firm are used in many different industries to collect and recover dust and other abrasive materials. The book is replete with photos of actual applications. Some of the type of fittings, fans, and blowers used are shown and explained. Kirk & Blum Mfg. Co.

46 **Flexible Exhaust Tubing**—This is a 6 page folder that shows with illustrations, tables and charts the applications to which this tubing may be applied. Tube is suitable for air, gases, powdered or granular materials, or exhausting other light solids. Flexible Tubing Corp.

TOOLS

47 **Rope Knowledge for Riggers**—This is a pocket-size bulletin for men who have to handle rope and tackle. The 48 pages are replete with information illustrated with drawings to show how to handle rope, tie many knots, rig tackle, definitions of blocks and tackle and rules and hints for safe lifting. Columbian Rope Co.

48 **Hand Power Tools**—This 36 page bulletin on the full line of equipment made by this firm illustrates, describes, and explains such equipment as: Chain saws, electric hand planers, circular saws, electric hand drills, flexible shaft grinders, buffer, and sanders, and many attachments for these tools to make them more versatile. Mall Tool Co.

49 **Wire Rope Selection**—This 120 page book has for its purpose the dissemination of information useful in selecting, buying, and using wire rope. Another function is to establish factual standards. The various types of construction and materials in wire rope are discussed. Tables and charts with equations for application are provided. Spooling and reeling, splicing, socketing, fittings and attachments, and assemblies are discussed. Really a worthwhile book. Wire Rope Institute.

50 **Air and Liquid Couplings**—A 30 page general catalog of the products of this company. Illustrated with drawings and equipment photos of the various types of quick couplings for air and liquids. Specification tables, dimensional drawings are given to aid selection of proper coupling for application. E. B. Wiggins Oil Tool Co., Inc.

51 **Pressure Handle for Drills**—This 4 page bulletin explains how the pressure handle works in relieving the worker of the strain of pushing. Photos show various applications and how the handle is applied to nearly any drill. Price is given. Pressure Handle Co.

52 **Adjustable Pipe Threader**—Form 77 explains how these power driven pipe threaders operate and how they can also cut bevel, and groove. Photos show the actual use of the machine and the highlights of its construction. Specifications, recommended accessories and tools, and price lists for all are given. Beaver Pipe Tools, Inc.

TURBINES

53 **Mechanical Drive Steam Turbines**—Illustrated with: line drawings, dimensions drawings; close-ups of controls, nozzles, wheel, governor, and governor throttling valve. Photos of the complete unit are shown. Whiton Machine Company.

PIPING, FITTINGS

54 **Allowable Working Pressures Handbook**—For the use of fabricators and users of industrial piping systems this book gives the allowable working pressure for welding fittings in 5 classes of piping. Tables are based on ASME Construction Code, 1946, and American Standard Code for Pressure Piping. Covered are plant process, hydraulic machinery, district heating, and refinery, piping. Tube Turns, Inc.

TREATMENTS

55 **Substitute for Soda Ash in Feed Water Treatment**—This is a technical paper offered to help operators during the soda ash shortage. It discusses various methods that may be employed to secure properly treated feedwater using little or no soda ash. Practical and useful. W. H. & L. D. Betz.

56 **Bromox Water Treatment**—Six pages of explanation about this method of treating water to eliminate the undesirable effects resulting from the chemical treatment of water. This is reputed to free the water from factors causing irritation, objectionable tastes, and odors, while controlling the pH or ionization of the water. Sterne & Maloy Company.

57 **Rapid Reactors for Water Conditioning**—This 12 page bulletin, No. 4425, contains detailed explanations of the process and operation of these rapid reactors. Color scheme and line drawings depict the action and component parts of the equipment, which covers the ranges from 0 to 100 gpm, 100 to 500 gpm, and from 500 to 3000 gpm. Cochrane Corp.

58 **Electronic Processing of Water**—This folder of 28 pages fully describes the purposes, functions and uses of this electromatic electronaire. It shows why there is a necessity for use of this device, what it is, how it functions, what it does, how it is used, and what its capacities are. Prices are listed. Instructions for the installation of the various models complete the folder. Ample drawings and photographs illustrate the material. Electromatic Engineering Co.

59 **Soot Remover, Fuel Oil Treatment**—Two bulletins, issued recently, cover fuel oil treatment and procedure and soot removal. An explanation of what takes place when sludge forms is presented and the difference between treated and untreated tanks is explained by description and drawings. Method of use of the compound is given. The bulletin on soot removal shows the difference in boiler tubes when treated and untreated and gives information on loss of efficiency due to soot formation. Alladdin Laboratories, Inc.

60 **Cleaning Solvents**—This bulletin, No. 1995, contains information on flash points, boiling ranges, chemical constitution, toxicity, trade names, on those solvents most frequently used for cleaning. It helps selection of a solvent for a particular job. DuBois Co.

MISCELLANEOUS

61 **Coating's Handbook**—This new handbook, 31 pages, describes how this company handles the problems of condensation drip and pipe preservation. It tells what their insulation type coating does, how it can be used, methods of application, and what users say about the product. It includes many charts and graphs to show the need for and the effect that this coating has upon applied surface. Innumerable photographs are used to illustrate its contents. J. W. Mortell Co.

MISCELLANEOUS

62 **Overhead Crane Control** — Consisting of a simple rotor and a stationary field member, this unit, known as the Magnetorque, exerts all braking forces electromagnetically. Since there are no rotating parts, no friction, no metal-to-metal contact, adjustments, etc., there is nothing to wear out. Seven charts give speed-load curves, magnetic, and breaking characteristics of the unit. Typical applications and advantages are included in this 6-page Bulletin No. C-39. Harnischfeger Corp.

63 **Moulded Fabric Bearings** — Bulletin HB-542, 4 pages, describes performance qualities produced by special methods of moulding resin-bonded fabrics to the finished shape and size. A chart shows the comparative performance of moulded and machined surfaces, while photographs illustrate these two surfaces. Drawings are also used to illustrate this point: one showing comparative installation clearances, another the effect of heavy impact or shock loads, another the effect of misalignment, while a fourth shows the effect of shifting pressures. Gatke Corp.

64 **Steam Jet Heaters** — This 20 page catalog contains a line of steam jet heaters for liquids. Photographs and text describe the various heaters and sparger nozzles, together with general information on their construction and operation. Tables and drawings give complete data on dimensions, connection sizes, weights of the various types and piping arrangements. Typical applications are diagrammed. Schutte and Koerting Co.

65 **Properties of Low Carbon Nickel Steel** —This is a 16 page bulletin, No. EU-93/20, which explains with texts, charts and tables the tests that have been run on low carbon 8½ per cent nickel steel. The effects of heat treating, quenching, welding, and section size are brought out. International Nickel Co., Inc.

66 **Oil Purifier**—Bulletin No. A-102 is a 4 page illustrated explanation of the lubricating oil purifier made by this firm. A colored indexed flow drawing explains the operation. Specifications are given as are dimensions. Hilliard Corp.

STANDARD ENGINEER'S REPORT

RPM CALOL

TEST DATA

UNIT G.E. 5000 KW Steam Turbine — Horiz. Steeple Compound. Steam — 1250 lbs. - 750° F.

LUBRICANT Calol OC Turbine Oil — 9

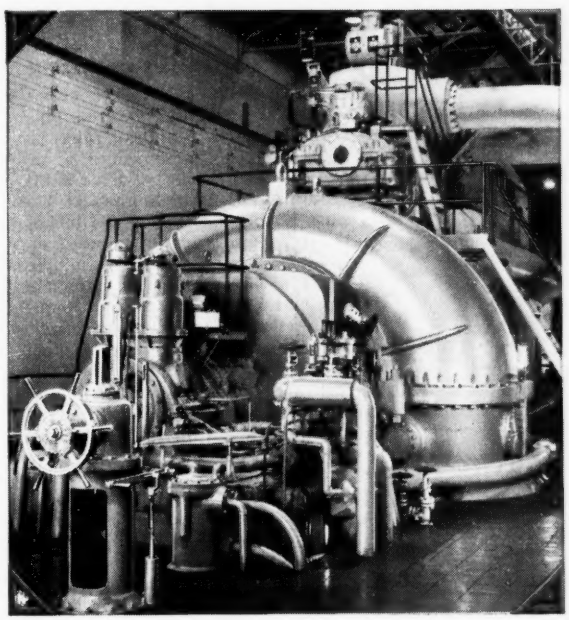
TEST PERIOD 4 Years —

CONDITIONS Operation of Generator

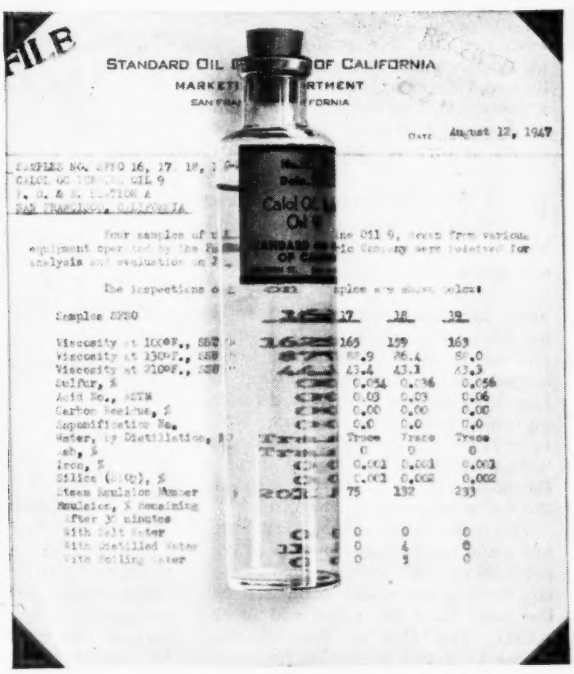
LOCATION San Francisco Station A

FIRM Pacific Gas & Electric Co.

SAME OIL CHARGE USED IN TURBINE FOUR YEARS SHOWS NO DETERIORATION



More than four years ago the lubrication system of this turbine-generator was charged with Calol OC Turbine Oil—9. After continuous operation on this same oil charge during all of that time, a laboratory analysis showed the oil had not increased in acidity or deteriorated. Inspection of lines, sumps, and governor control mechanism showed them to be clean and free of sludge and lacquer. Journals remained in good condition. Calol OC Turbine Oil resists both oxidation and corrosion.



Note how clear this sample of the Calol OC Turbine Oil charge remained after 4 years of use - figures can be read through it and there is no deposit at the bottom of the bottle. The actual specifications of the used oil from the turbine-generator is one of the four sets shown here.

REMARKS: Calol OC Turbine Oil is specially compounded to provide long service and give full protection to all vital bearing surfaces. It contains a highly effective oxidation inhibitor which resists the action of air, heat and moisture, preventing sludging and lacquer formation, reducing oil maintenance costs to a minimum. Its corrosion inhibitor and excellent metal-wetting ability stop rusting, even in initial operation of turbines. Calol OC Turbine Oil is made in five grades to meet various installation conditions.

STANDARD TECHNICAL SERVICE conducted and reported this test: If you have a lubrication or fuel problem, your Standard Fuel and Lubricant Engineer or Representative will give you expert help; or write Standard of California, 225 Bush Street, San Francisco 20.

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THE CALIFORNIA COMPANY • Denver, Colo. THE CALIFORNIA OIL COMPANY • New York

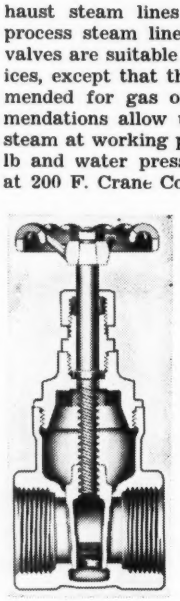
NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Generation, 53 West Jackson Boulevard, Chicago 4, Illinois

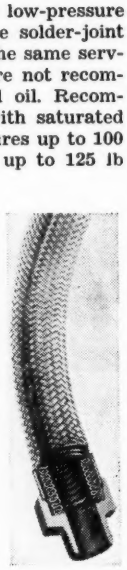
A Steam Turbine Flushing Oil. A new flushing oil, engineered for cleaning the oil circulating systems of steam turbines, has been announced. The new product is effective for both new turbines and older units. It is said to remove abrasive contaminants, grease type slushing compounds, sludges, and organic acids. It contains an effective rust inhibitor for protecting clean metal surfaces. Itself a light viscosity lubricant carrying additives—and not a non-lubricating solvent, the flushing oil does not affect the lubricating efficiency of turbine oils. Gulf Oil Corp.

B 100-Pound Brass Gate Valves. These valves are furnished in two types, the No. 410 screwed-end valve in sizes ¼ to 2 in., and the No. 1320 solder-joint valve in sizes ⅜ to 2 in. These are non-rising-stem valves. The upper portion of the body is cylindrical in shape, similar to the design that has been used only in steel valves for the highest pressures This design is said to combine maximum strength with light weight. The cylindrical shape of the body reinforces the seats against the wedging action of the disc.

The ends of the solder-joint design are made to fit closely over hard copper tubing. The joint is soldered by end feeding, the solder being fed into the joint from the outer end of the socket. The disc is the one-piece wedge type and is guided by means of long guides which assure correct seating. Valve seats are cast as part of the body. The stuffing box is packed with molded asbestos, and can be repacked while under pressure when the valve is wide open. The screwed valves are recommended for use on low-pressure condensate lines, exhaust steam lines and low-pressure process steam lines. The solder-joint valves are suitable for the same services, except that they are not recommended for gas or fuel oil. Recommendations allow use with saturated steam at working pressures up to 100 lb and water pressures up to 125 lb at 200 F. Crane Co.



Gate Valve

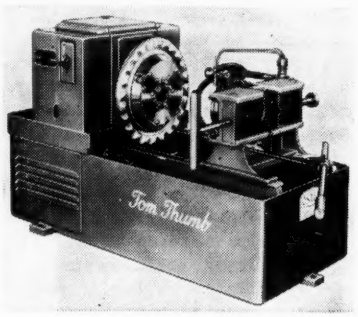


Hose Coupling

C Flexible Hose Coupling. A new quick soldered coupling for use where moderate temperatures are involved—not to exceed 300 F. The new quick soldered couplings are available either completely assembled to hose at factory or can be purchased separately for assembly at your plant.

Features of this quick soldered coupling are said to be as follows: It is a two-piece male coupling including a male body and a loose collar. The collar is designed so that when the hose is cut, it holds the braid tight, preventing unraveling and slipping, thus producing a hose and braid end automatically prepared for soldering. When soldered to the body coupling, it becomes one solid unit. The collar also controls the height of the solder leaving an exposed length of collar without heat injury to either hose or braid. It protects and supports the hose at the most vulnerable point thus eliminating any need for reinforcement. Brockway Co.

D Portable Threading Machine. No. 582 designates this electrically powered pipe and bolt threader. Standard range is ¼ to 2 in. pipe. Extra range ⅛ in. pipe. Range with special drive shaft 2½ to 8 in. pipe. Bolt range ¼ to 1½ in. pipe. Nipples as short as 3½ inches in the 2 in. size can be threaded on both ends without using a nipple chuck. Pipe or studs as short as 2½ in. can be threaded on one end. Regular equipment consists of the complete machine for bench use. A steel stand equipped with 16 in. wheels is furnished as an extra when frequent portability is desired. Die-head is the quick-opening, adjustable floating type with top opening to permit view of thread as it is cut, and bottom opening for chips to fall into pan Slides out of way for cut-off operation. Carriage has new type lever feed which pulls the carriage forward instead of pushing it. Carriage floats on all steel ways to conform to irregularities in pipe. Thread length gage gives direct reading to insure duplicate threads of standard length. Motor is universal, reversible, variable speed for 110 v, either a c single phase or d c. Drive from motor by V belts which are protected from oil and grease. Spindle of semi-steel, runs in ball bearings. Oil pump is reversible, accessible, and has adjustable relief valve. Oster Mfg. Co.



JUNE, 1948

POWER GENERATION
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If it's power piping equipment it's in the CRANE line

Valves, fittings, piping accessories, and fabricated pipe—the Crane line includes them all! In steel, iron, brass, or alloy materials, Crane gives you the most comprehensive selection in all types of equipment for power, process, or general utility piping.

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This high pressure steam system, for example, shows how the Crane line makes easier work of specifying and ordering. One catalog puts everything at your finger tips. One order to your Crane Branch or Wholesaler covers all the equipment you need. Undivided responsibility for materials helps you get a better installation—on schedule! The high quality of all products from Crane means uniform dependability throughout the installation.

Your local Crane Branch is well-stocked to help you get these important piping advantages.

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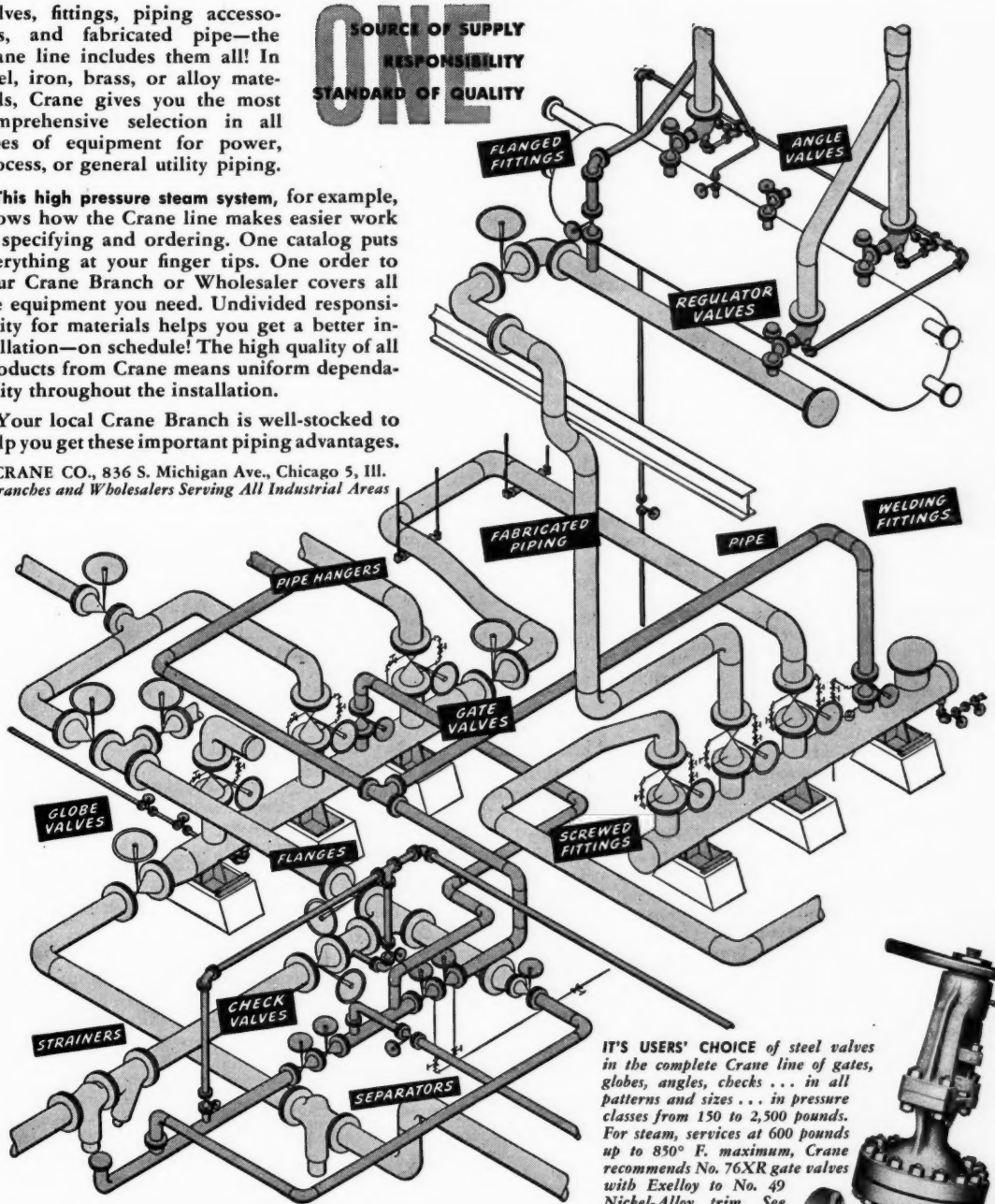
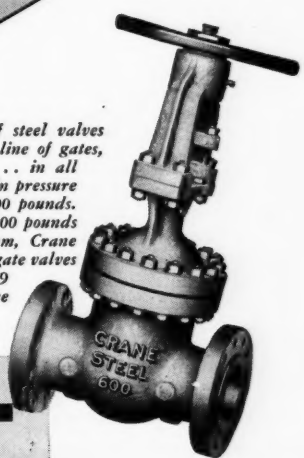


IT'S USERS' CHOICE *of steel valves in the complete Crane line of gates, globes, angles, checks . . . in all patterns and sizes . . . in pressure classes from 150 to 2,500 pounds. For steam, services at 600 pounds up to 850° F. maximum, Crane recommends No. 76XR gate valves with Exelloy to No. 49 Nickel-Alloy trim. See your Crane Catalog.*



EVERYTHING FROM . . .

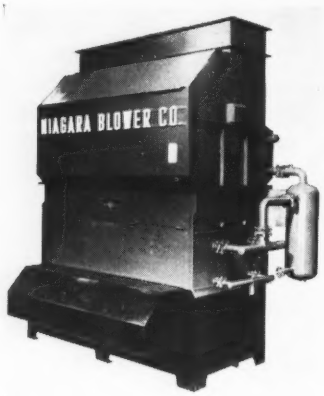
VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM

E Refrigerant Gas Condenser. The condensing in this unit is done by passing the gas through two coils located in an air stream. First, the dry coil, together with the Oil-Out, takes out the super-heat and condenses and separates oil vapor from the refrigerant. Second, the wet coil condenses the gas at a low temperature. The spray water is re-circulated and make-up is needed only for the small evaporation.

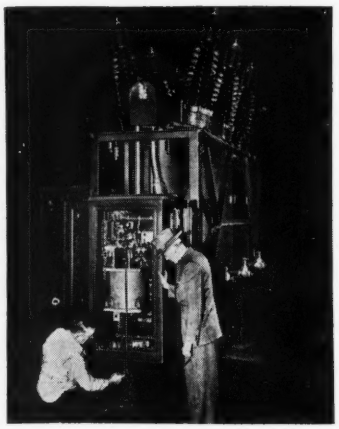
The new design affects the head pressure control method. The interior



of the casing is partitioned into two parts so that by the operation of dampers, either all fresh air may be used or any degree of recirculation of air. This varies with the condensing load and with changes in air temperature according to the weather, so that the compressors are operated automatically at the desired head pressure, which in practice is the minimum required properly to distribute the refrigerant. In winter, when the heat in the refrigerant gas is not sufficient, an electric heating element in the spray water tank goes into operation automatically to prevent freeze-up. In this new design all dampers are located internally, protected from outside weather conditions, assuring no interruption to automatic operation. Aeropass condensers are manufactured in units ranging from 10 to 100 t rated capacity. Niagara Blower Co.

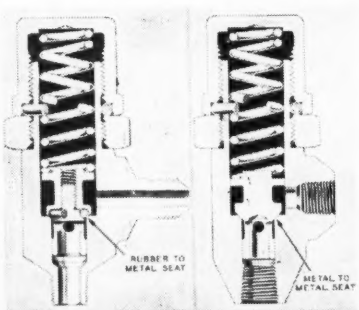
F 69kv Oil Circuit Breaker. A new high-speed, quick-clearing (8 cycle), outdoor, frame-mounted oil circuit breaker—Type FZO-151—has been announced. This breaker, available in 69 kv ratings from 500,000 to 2,500,000 kva interrupting capacities, features improvements such as: all welded steel fabrication throughout, including the pole unit top frame; simplified mechanism rearranged for easier maintenance, and decreased total weight.

A special Ruptor interrupting device, capable of ultra-high speed circuit interruption, a simplified high

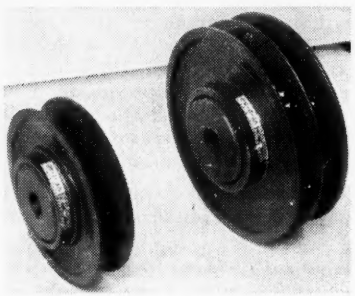


speed electro-pneumatic or solenoid operator, both mechanically trip free, and an improved new design low-inertia, pole-unit mechanism. When pneumatic operation is furnished, this breaker permits 20 cycle reclosing service if specified. The contact mechanism in each pole unit is connected to an enclosed common pull rod through a rotating shaft with corrosion resistant bearings. This shaft and bearing combination also acts as an efficient oil and gas seal isolating each pole unit. The mechanism with adjustment stops, and bushing transformer terminals, are readily accessible for routine maintenance by removing a weatherproof cover atop each pole unit. Allis-Chalmers Mfg. Co.

G Adjustable Relief Valves. A new series of hydraulic and pneumatic relief valves has been introduced. The valves are available in five pressure ranges: 0-15, 10-50, 40-125, 115-250 and 235-450 psi, and can be set by means of external adjustment to the particular pressure range involved. Adjustment is effected by positioning a threaded cap which determines spring pressure on the shut-off piston. The cap is sealed by a threaded follower ring which compresses an O-ring held in the cap. The body and cap elements are available in aluminum or brass, while the springs and metal-seat pistons are made of stainless steel. The rubber seat piston is of brass. An arrow indicates direction of relief flow. Available in each of six basic sizes from ¼ to ¾ in. Sizes 1 in. and larger, as well as pressure settings to 1000 psi, are obtainable on special order. Parker Appliance Co.



H Adjustable Pitch Diameter Sheaves. Fhp adjustable pitch diameter sheaves, available in 14 sizes, seven single groove and seven double groove, have been introduced as a standard item. The arrangement of the single groove sheave incorporates



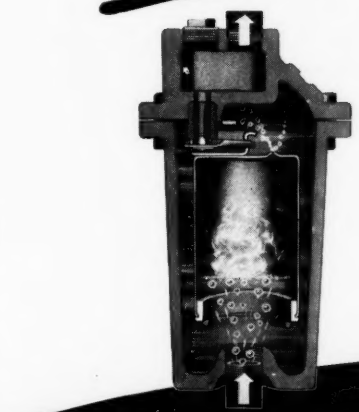
a stationary flange with a hub which is bored, keyseated and provided with a set screw that enables shaft adaptability. The outside diameter of the hub is threaded to suit the removable flange. It is also milled at 180 deg to receive positioning set screws in the loose flange. The double groove sheave is identical except that the stationary flange is the center spider for the two grooves and is provided with threaded hubs to receive loose flanges on both sides. The design of the sheaves is such that the FO, FA and FB (also A or B) V-belts can be accommodated through a variable range of diameters as listed in any one size of sheave. Worthington Pump and Machinery Corp.

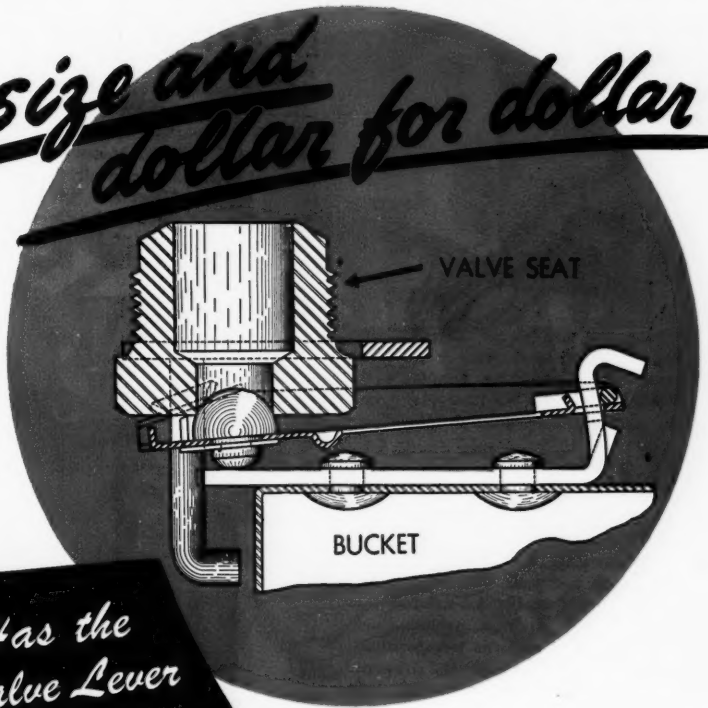
I 2300-4600 V Motor Starter. For protecting high voltage motor circuits against damage from short circuits, a new line of starters for use with 2300-4600 v motors is available. These new starters limit maximum fault current that can be obtained on any system approximately 25,000 kva, which is easily interrupted by the Type ZHS magnetic contactor used in these starters. The interrupting capacity rating of the ZHS is actually 50,000 kva.

The Valimitor motor starter is a self-contained unit. The upper half of the front cubicle contains the disconnect switches and Valimitors. The magnetic overload relays are in the lower half of this cubicle and the automatic field-switching panel for the synchronous motor field is also mounted in the lower part of the cubicle. The ZHS magnetic contactor is mounted in the oil-tank at the rear.

WHY AN ARMSTRONG STEAM TRAP GIVES YOU GREATER CAPACITY

Size for size and dollar for dollar





Only Armstrong Has the "Free-Floating" Valve Lever

● The Armstrong "free-floating" valve lever makes possible large capacity in a small trap and this pays off in *less weight . . . lower price . . . less installation cost . . . less heat-losing radiation area.* Here are two design features that make this possible:

1. High leverage that permits a small, lightweight bucket to pull open a large valve. A small bucket means a small trap and a large valve orifice is essential to big capacity!

2. Sufficient bucket travel to get the valve far enough from its seat that it does not restrict the orifice. A wide open valve means greater discharge capacity!

And, remember, Armstrong continuous discharge capacity ratings are based on actual tests with hot condensate at given steam pressures. Any trap will handle more cold water than it will hot condensate, and some trap capacities are based on cold water ratings.

To get the most for your money, specify ARMSTRONG.

ARMSTRONG MACHINE WORKS
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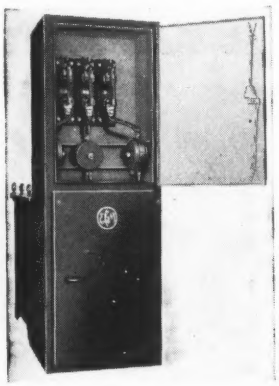
● Send for the Steam Trap Book. This is a 36-page hand book on condensate drainage. It's low on selling and high on telling — how to select, install and maintain traps. Includes tables, data and diagrams. Also prices, specifications and capacities of Armstrong Traps. If you want a copy, just send for it.

ARMSTRONG *Inverted Bucket* STEAM TRAPS

Factory Representatives in 48 Key Cities . . . Traps Stocked at 147 Points

These starters are built to provide across-the-line starting, also in the reduced voltage starting style. 2300 v top ratings are 600 hp for 60 cycle

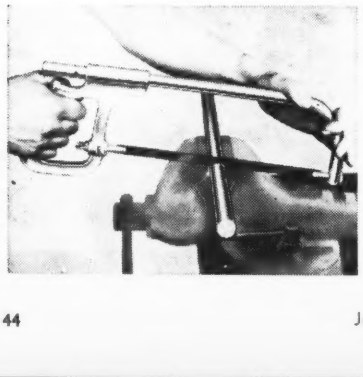


systems and 300 hp for 25 cycle systems. On 4150 and 4600 v systems, top rating is 600 hp for 60 cycle service and 250 hp for 25 cycle operation. Electric Controller & Mfg. Co.

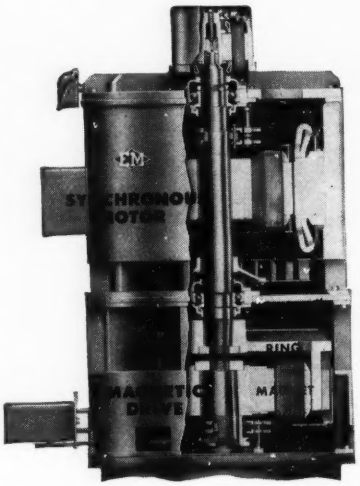
J Coolband for Hot Jobs. The Coolband is an efficient perspiration retainer designed to provide greater comfort for men working on hot jobs.

Fitting comfortably all-around-the-head, the soft, sponge rubber Coolband constantly absorbs perspiration, creating a cooling effect. By preventing perspiration from dropping into the eyes and on glasses or goggles, the Coolband promotes better working comfort and efficiency. Light in weight, the Coolband clings gently to the head without binding. It may be thoroughly cleaned by hand-squeezing in soapy water and may be sterilized by the same method, using customary germicidal solutions. Mine Safety Appliances Co.

K Hacksaw Frame. The important feature of the rigid hacksaw frame is its strong construction, obtained by the one-piece steel tube back fitted into the precision-machined cast-aluminum handle. This permits tightening blade to high tension, which is claimed to maintain true alignment without twisting the blade. Alignment is further assured by machined blade holders, whose squares are received by accurately milled slots. The handle gives a comfortable, firm grip. It is adjustable for 10 and 12 in. blades. All steel parts are cadmium plated; total weight is 1 lb 6 oz. Machine Rebuilding Co.

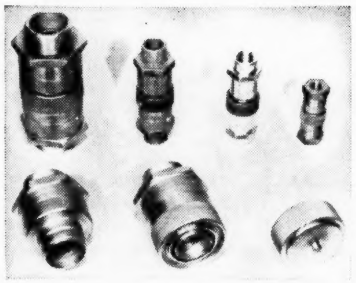


L Adjustable-Speed Vertical Drive Unit. Newly available vertical synchronous motor magnetic drive unit gives smooth adjustable speed control for centrifugal pumps. Motor drives the ring of the magnetic drive at constant speed. Magnetic member of magnetic drive mounted on gear shaft operates the pump at speed required by liquid level control. Unit offers



smooth, wide-range speed control, precludes hunting and eliminates frequent motor starts and stops. Shown is 250 hp 1200 rpm vertical synchronous motor magnetic drive unit, which operates 200 rpm vertical sewage pumps through a reduction gear. Electric Machinery Mfg. Co.

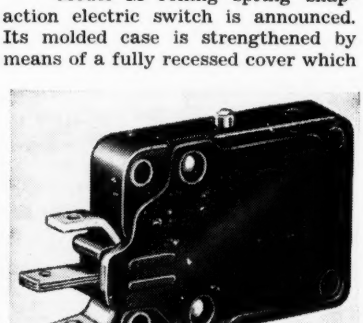
M Automatic Sealing Couplings. Automatic shut-off upon disconnection and instantaneous flow upon connection is the important feature of a new series of quick couplings known as the 1300 series. They are available with the valve in either or both halves of the coupling. When used together these valves are said to be mutually activating to open when connected, and close when disconnected. A valved coupling may be used with an open nipple, in which case the nipple end opens the valve upon connection. When an open coupling is used with the valved nipple, the latter is opened only by flow, thus giving a check valve action. It is available in sizes from ¼ to 2 in. and in dural, bronze



and steel. Applications include industrial closed hydraulic systems, tank loading of petroleum products and other fluids, and steam and pneumatic lines. Roylyn, Inc.

N Low-Current Indicating Lamps. Announced are a new group of units with T2 slide-base bulbs. This bulb is noted for its very low current characteristics, namely as low as 0.038 amp on low voltages, 6-12-24 v. They are suited for use with a series-resistor on 120-220-440-550 v. These units are all for single-hole panel mounting. The No. 18T2 unit features a 2 in. dia beehive glass lens, and mounts in a $1\frac{1}{2}$ in. dia hole. The No. 53T2DE unit has a glass lens turned into a machined metal cap that is $1\frac{3}{8}$ in. in diameter. It mounts in a $\frac{7}{8}$ in. dia hole. The No. 6T2FL unit has a $1\frac{1}{8}$ in. dia flat lens. The unit mounts in a $1\frac{3}{8}$ in. dia hole. For voltages such as 120-220-440, resistors or brackets are available. H. R. Kirkland Co.

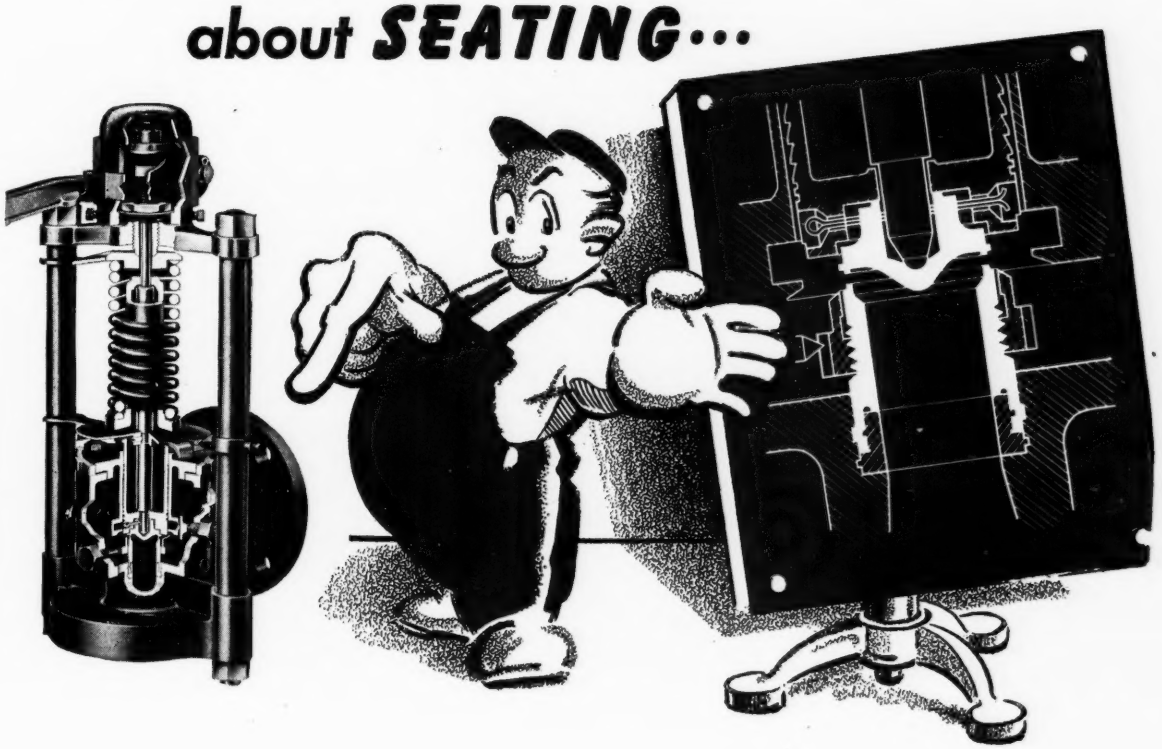
O Miniature Switch. Model M rolling spring snap-action electric switch is announced. Its molded case is strengthened by means of a fully recessed cover which



is inserted clear of the four mounting holes which are $\frac{3}{32}$ in. dia. Size of barriers between the terminals has been increased. To make wiring easier, heavier solder terminals are used with 0.082 in. terminal holes. This new Model M switch is made for single and multiple assemblies. Four of these switches can be mounted in a space of less than $1\frac{1}{8}$ in. It is made with single pole, single or double throw contacts and is rated at 10 amp 125 v, a c. Acro Electric Co.

We Studied SAFETY VALVE LEAKAGE

—Here's what we found out about SEATING...



We found—what most power plant men already know...that in order to be tight, a safety valve must have matched, wear resistant, corrosion resistant seating surfaces, and that the disc must seat square.

We found—what power plant men have long suspected...that uneven expansion, causing dragging of one seating surface over the other, can destroy the seat so completely that the safety valve has to be overhauled or replaced, even though it has never been popped.

We found...that when nozzle and disc are made of alloys with the same coefficient of expansion, and with sections designed so that their rate of heat absorption is the same, destructive drag is eliminated. That is the reason Foster 38-8V Safety Valves can be guaranteed to stay tight.

To you...this means elimination of costly boiler outage due to safety valve leakage. Other guaranteed advantages are...consistently accurate popping...minimum blow-down, which can be held to as little as 1%... highest relief capacity for a given nominal valve size... and extremely low maintenance.

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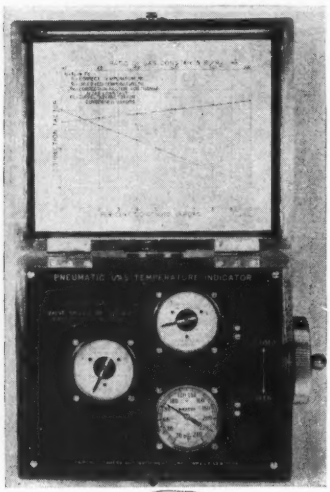
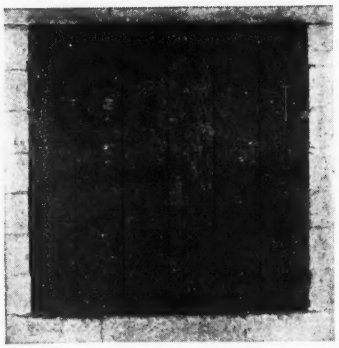
P Gas Temperature Indicator. Unit 263 laboratory gas temperature indicator is now available for measuring gas temperatures to 5000 F. The insertion of a probe into the gas stream and operation of a single control valve on the instrument case is all that is required to obtain gas temperature measurements. Accuracies of 1 per cent are said to be guaranteed up to 2000 F. In the 2000-5000 F range, reproducibility of plus or minus 2 per cent is guaranteed. Temperature probes of suitable metals are furnished for temperatures to 2300 F, and water-cooled probes with iridium orifices are furnished for temperatures to 5000 F. Probe diameter, length and shape are tailored to customer specifications. The Fairchild Unit 263 indicator is suited for use with gas turbines and general industrial laboratory use. Fairchild Camera and Instrument Corp.



Q Chrome-Base Concrete. A high-strength, chrome-base refractory concrete, known as Kromecast, which is able to withstand temperatures as high as 3100 F, has been developed. The product is of major importance for industrial furnaces because it makes an easily installed concrete combining the refractory and slag-resisting properties of chrome-base materials with the ability to support loads at high temperatures. It can be poured into place or applied by plastering or with a cement gun. It is said to possess exceptional volume stability at temperatures up to 3100 F, while providing protection against attack by fuel slags, metallurgical and chemical slags, molten materials and other reactive products.

Applications include: furnace walls, hearths and floors in metal heating and forging furnaces; car tops; electric furnace roofs; water-cooled boiler

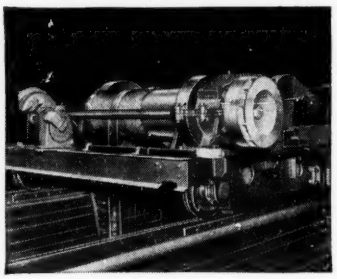


furnaces operating at high temperatures; furnace door and frame linings; patching furnaces which have been damaged; forming special shapes quickly and inexpensively. For use in furnaces where temperature and spalling conditions are not as severe as those requiring the use of Kromecast, the company announced a second new product, Hydrochrome. This chrome-base concrete has a temperature use limit of 2800 F and is recommended for the great majority of water-cooled boiler furnaces and for metal processing furnaces with moderate operating temperatures. Babcock & Wilcox Co.

R Waterproofing Fabric. A new inorganic waterproofing membrane fabric woven from fiberglas continuous yarns helps end the many fabric disadvantages found in the conventional organic fabrics used by experienced roofing and waterproofing contractors. Glasfab is a smooth, evenly woven, open mesh fabric, permitting full penetration, impregnation and pick-up of the conventional waterproofing compounds. It is said to be waterproof, will not rot or decay and will withstand hot applications up to 1000 F with safety. The fabric has a strength factor with the warp of 64 lb per in. wide strip and 92 lb with the fill per in. wide strip. Thread count is 24 threads per in. for both warp and the fill. Lexington Supply Co.

S Vacuum Gage Dial. A new vacuum gage dial graduated 0 to 30 in. mercury vacuum in 0.2 of an inch increments, and with barometric pressure readings from 29 to 31 in., is announced. The zero or a vacuum gage is atmospheric pressure at sea level. Changes in atmospheric pressure will, therefore, affect the accuracy of the gage. The inaccuracy may be considerable if a vacuum gage is in a room pressurized by force draft. A difference of 1 in. in atmospheric pressure causes a gage error of about 3½ per cent. The gage may be corrected for changes in barometric pressure and thus assure more accurate readings. Such corrections are made with the external micrometer pointer adjuster. The dial also reads counter clockwise to prevent any confusion with a pressure gage, and is designed with the subdivisions in steps for ease in reading to 2/10 of an inch. Helicoid Gage Div., American Chain & Cable Co., Inc.

T Magnetic Crane Control. This new a c crane control provides unusual hoisting smoothness and accuracy. Magnetorque is a simple unit through which braking forces are exerted magnetically. The unit governs the action of the hoist motor which is directly connected through the crane gear train to the hoist drum. The hoist motor drives the load both up and down but cannot be energized until the unit has been excited. There are no rotating electrical parts in the unit. Since braking forces are exerted magnetically, without friction and metal-to-metal contact, there is nothing to wear. There are no friction linings to replace or adjustments to be made. Magnetorque is also available with drum type or full magnetic control. It can also be furnished with all-position dynamic braking. Harnischfeger Corp.



U Upending Bar For Drums. Manual lifting of heavy steel drums is a common cause of hernia and accident. This drum upending bar was designed to make possible safe, one-man lifting of the heaviest drums. It is a solid steel tool which utilizes the principle of leverage. With this bar, 36 in. long, 1 in.

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solid steel, the lifting force required is said to be only 30 per cent of the weight of the full drum, so that only 90 lb will lift a 300 lb drum. The bar hooks firmly over and under the lip of the drum. Built of 1 in. solid steel. Melooz Mfg. Co.

V D C Timing Motors.

A new series of timing motors has been announced. These Series 6300 motors are matched to receiving tubes. By operating over a period of time through the enclosed gearing, these new motors will integrate the very small instantaneous energy input from a receiving tube and perform almost any desired amount of work.

The motor, with high impedance winding, is said to require less than 270 milliwatts power input. Operating

in the plate circuit of a small receiving tube, the 6300 series motor reputedly permits translation of a minute electrical function into a large amount of work without the use of thyratrons or other power equipment. Special rotor winding has approximately 7000 ohms running impedance and draws only 6 ma at 45 v d c. The permanent magnet type motor has a totally enclosed gear train. Speeds are 3200 rpm down to 4 rp hr. The motor is compact, 2⅛ in wide, 2½ in high, 1⅜ in deep, and weighs 6 oz. A. W. Haydon Co.

W Examining Lube Oil.

Just announced is a set of engine room equipment for examination of Diesel lubricating oil. The apparatus is designed especially for use of engine attendants, and is compactly housed in a steel floor cabinet 20 in. deep, 23 in. wide and 36 in. high. The items selected are said to provide simple yet accurate means for measuring the amount of the entire group of deterioration products responsible for all engine deposits; fuel dilution; water, dirt, scuff metal particles and acidity; also water and sediment in fuel, and its gravity. The tests are made in one-half hour per week per engine, and the routine use of this equipment establishes a continuous record on the lubricating oil. It is claimed also, that the change in rate of contamination is a sensitive indicator of conditions inside the engine. Gerin Corp.

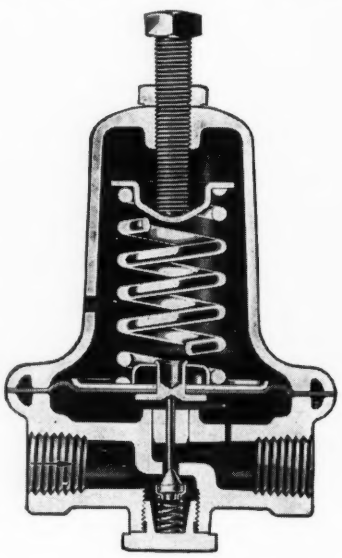
X Utility Pilot Light.

These utility colored pilot lights Lights are designed for signal applications, warning, decoration, and general illumination. They are available in one type of 8-prism lens to 4 separate lens or more, mounted on a plate 4½ in. wide, the depth varying with the number of lens. The lens come in five colors of unbreakable plastic, and are lighted by No. 93S8 lamps for single contact bayonet base of 12 v, 15 cp; or No. 6S6 Candelabra lamps for screw base in 115 v types.

The snap-on cover plate construction makes removal easy. A variation of the Pilot Light, the DPF9 uses a 9 in. 6 w fluorescent lamp for illumination purposes only. Cannon Electric Development Co.

Y ¼ in. Reducing Valve.

The Type 67 is a self contained pressure reducing regulator for air or gas service applications. It is said to provide superior close pressure maintenance under exacting conditions on applications such as instrument air supply service and panel pneumatic loading for remote hand control. Specifications are: ¼ in. size only. Capacity is up to 6 cfm at 100 lb inlet, 5



lb reduced pressure. Reduced pressures are 3 to 20; 15 to 40; 25 to 75 lb. Initial pressures are 250 lb, 150 F max. Die cast body. Mounting is flush or at equipment. Fisher Governor Co.

Z Megohmmeter.

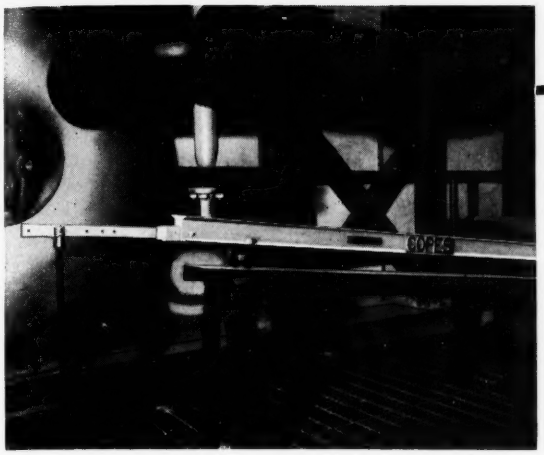
The Model 1450 is a portable instrument utilizing a highly stable electronic bridge circuit which is supplied by a self-contained regulated power supply operating directly from an a c line source. It is equipped with a long scale indicating instrument mounted in a cast aluminum sub-case attached to the instrument panel and sealed

against dust and moisture. The control panel is equipped with a 5-position range selector switch, infinity adjusting knob, standardizing adjusting knob, standardizing switch, a c line switch and indicating pilot light. The instrument utilizes a movement designed for this application, and is said to be constructed to assure permanent accuracy and constant operation under continuous handling and use of commercial and laboratory applications. Specifications are: Power supply, 105 to 125 v, 40 to 60 cycles a c, are required. The power is 40 w. 210 to 250 v can be supplied at additional cost. Tubes: The necessary tubes are: 2 Type 6SH7, 2 Type VR105, 1 Type 5Z4. Accessories: The instrument is provided with a removable 6 ft a c cord assembly. Weighs 11.75 lb. Cole Instrument Co.

AA Steam Trap.

A new line of steam traps that have capacities up to 24,000 lb of water, has been recently acquired by this company. Operating on the float-valve principle, and designed for easy attaching to any steam line from ½ to 2 in., the trap discharges in a continuous and uninterrupted stream all water and air it collects. Body and head are made of high-quality semi-steel, and all parts, including the air vent which is located on the outside of the body.

Trap operates without time lag so that condensate is removed at a speed equal to, or faster, than it collects. The traps are available in seven sizes, according to capacities. Leavitt Machine Co.



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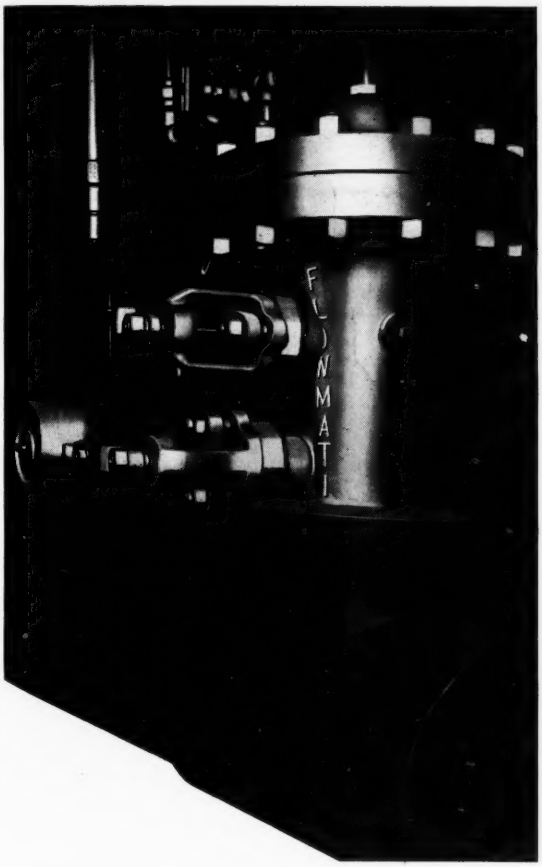

Direct-operated COPES Flowmatic Valve has the steam-flow element built integral with the bonnet

COPES Boiler Feed Water Regulators had been in service since 1924 at the Municipal Power Plant, Monroe, Louisiana. They had required no more than routine attention by plant personnel. So, when the 400-psi extension was planned, it was only natural to select the modern two-element COPES Flowmatic for the gas-fired Babcock & Wilcox boiler. Results have been all that could be desired. Water level is held within plus-or-minus one-half inch. Write for Performance Report 473 which tells the story.

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More and more plants in the laundry and dry cleaning industries, as well as other industries where steam equipment is used, are adopting the Yarway Impulse Steam Trap because of these obvious advantages—*small size, quicker heating, easy maintenance* (*only one moving part*), *low cost.*

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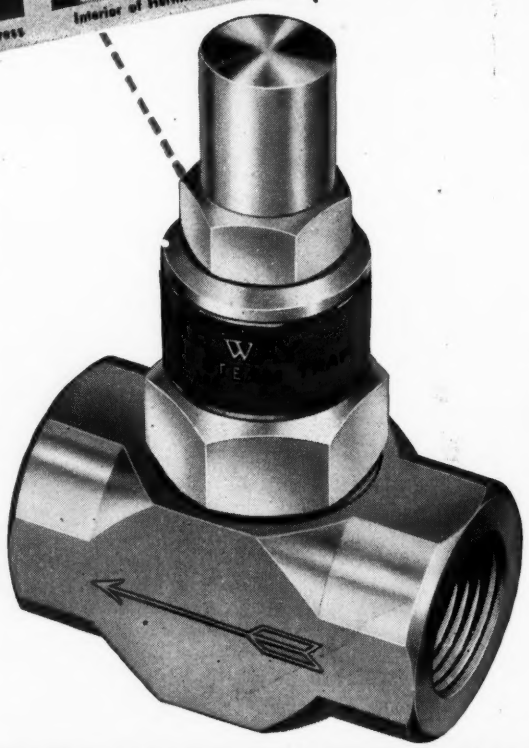

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YARWAY IMPULSE STEAM TRAP

WHAT LEADERS SAY

Recent Boiler Water Studies

By FREDERICK G. STRAUB

OF THE VARIOUS TYPES of difficulties that have been experienced in the steam water cycle of the steam power plant, that of boiler feed pump and regulating valves recently classified as corrosion-errosion appears to be very baffling. Several interesting papers have been given describing this difficulty and suggesting means of preventing this attack. (1) (2) (3)

During the last year, the author has had the opportunity to survey several large power plants in an attempt to explain and try to prevent the pick up of iron in the feedwater cycle. Since the attack in the feed pumps may involve the dissolving of the iron by the feedwater, the results of this survey may contribute some information toward the solution of this problem. This survey has not been completed.

The pH was determined in a flowing cell, thus preventing the exposure of the water to air prior to determining the pH value. Samples collected at the time the pH was determined were analyzed for ammonia, iron, and copper by colometric methods. The methods used are given at the end of the paper. The accuracy of the method was about ± 0.01 ppm for iron and copper and ± 0.02 ppm for NH_3.

Previous Research

Research had previously been conducted at the University of Illinois in which oxygen- and gas-free water was passed over steel and the pH and iron content measured before and after the water passed over the iron. The water had a pH between 6.6 and 7.1, with a specific conductance of around 0.6 micromhos and an iron content of 0.00 ppm before passing through the iron. After passing through the iron, the pH increased to 9.1, the conductance to 3 micromhos and iron to around 0.3 ppm. When sodium hydroxide was added to the water until the pH increased to around 9.2, there was no increase in pH or iron content caused by the iron passing through the steel. These results indicated that the oxygen-free water dissolved the iron as soluble ferrous hydroxide, which in turn increased the pH and conductance. When the pH was 9.2 or above, there was no iron dissolved.

If similar action were to take place in a pure steam passing through a turbine, there could be some iron dissolved at the wet end of the turbine and the condenser with an increase in pH. Thus the pH alone could not be used as a criterion of the tendency of the steam to dissolve iron. However, if the iron and the ammonia content were determined, along with the pH, a better picture could be made of what was happening.

Tests In 3 Stations

The tests in Station A involved sampling the steam leaving the boiler, the condensate at the condensate pumps, and the feed water at the boiler feed pump. Data were given to show the relationship between the pH and the iron in plant A as the pH of the steam varied. The change in pH for values above 8 in the steam was brought about by increasing the ammonia in the steam.

The results reported in stations B and C were on samples taken of the superheated steam, condensate from condensate pumps, and after deaeration in the deaerating heater.

The results from Plant A show that the pH of the steam when below 7 increases as the water passes through the system; and parallel with this increase in pH there is an increase in the iron content. The ammonia content remained constant, consequently the pH increase has apparently been caused by the iron dissolved from the system. As the pH of the steam increases the amount of iron pick-up decreases, so that when the pH of the steam was alr ost 9 in this station, there was no iron pick-up at the condenser and that between the condenser and the feed pump very little.

Relations of pH To Other Factors

In stations B and C, similar results were obtained as at Station A, only with a smaller degree of iron pick-up. In the case of Station B, a steam with a pH of around 7.1 showed an increase to 8.4 with an iron pick-up to around 0.08 ppm and a slight drop in the ammonia. Here again the iron was dissolving and increasing the pH value. In Station C the pH of the water increased as it passed through the system from 7.4 to about 8.1 with no increase in iron but with an increase of ammonia. Thus the increase in pH was apparently caused by the ammonia increase and there was no increase in the iron content.

Station C was the station showing no marked pick-up of iron and it is also the only one of the three stations which has been free from feed pump corrosion-errosion troubles.

The results assembled point out that pH control of the feedwater is not the answer to the prevention of the iron attack problem. Thus as the data indicate, a feedwater with a pH of 8.3 has picked up 0.10 ppm of iron while in Station C a feedwater with a pH of 8.1 has no iron pick-up. In order to have determined whether a feedwater is aggressive to iron, it is necessary to determine the iron and ammonia content as well as the pH. Once these data are available the advisability of modifying the pH value may be readily determined.

(Following this the author gave detailed instructions for tests for iron, ammonia and copper, which will be supplied on request.—The Editors.)

[1]Corrosion-Erosion of Boiler Feed Pumps and Regulating Valves; by H. A. Wagner, J. M. Decker and J. C. Marsh. *Transactions ASME 1947.*

[2]Materials as a Consideration in Modern Boiler Feed Pump Construction; by H. L. Ross; *Midwest Power Conference,* 1947, page 241.

[3]Boiler Feed Pump Corrosion—Here's What You Can Do About It; by H. L. Ross; POWER GENERATION, February 1948, page 104.

CORRECTION NOTES

BECAUSE of the prevailing production troubles in our printing plant, two credit lines were omitted, in some unaccountable manner, on the What Leaders Say pages of the April and May issues.

In the April issue, the article Why Turbulence Is Important to Engineers, by John S. McNown, page 51, was abstracted from his paper originally included in the Proceedings of the 1947 Annual Meeting of the Engineering College Research Council of the ASEE.

The work of Frederick G. Straub in the field of boiler water treatment and water chemistry, especially in the modern high-pressure high-temperature power plant, is too well known to require extensive explanation. He is research professor in chemical engineering at the University of Illinois and since 1924 he has conducted outstanding research work on the various chemical and metallurgical problems encountered in the steam-water cycle of the modern power plant, such as embrittlement, scale, corrosion, turbine blade deposits and the like.

Professor Straub received his B.S. degree in Chemical Engineering at U. of I. in 1920, became research fellow at Mellon Institute, worked for Semet Solvay Co., Syracuse, and later taught at Pennsylvania State College, where he received a degree of Metallurgical Engineer.

He is author of numerous books, articles and society papers on water treatment, is a member of ACS, AICE, and of the Boiler Code Committee of ASME.

The above material is from his paper before the 1948 Annual Midwest Power Conference at Chicago.

How Silica Removal Cut Power Plant Costs at Southern Advance

By D. G. COOPER
Chief Engineer,
Southern Advance Bag & Paper Co.

and

JOHN B. DAVIS
Water Conditioning Dept., Allis-Chalmers Mfg. Co.

Here's how silica removal from boiler feedwater halved boiler outages and cut turbine outages and maintenance costs to a minimum for the Southern Advance Bag & Paper Co., Hodge, Louisiana . . . Nine boilers are of capacities between 20,000 and 60,000 lb per hr . . . Five turbine generators have total generating capacity of 12,000 kw . . . BEFORE silica removal: 57 boiler shutdowns in 33 months, 834 boiler hours unscheduled outage, 133 tubes replaced, 29 welded; turbines sandblasted every 4 months, power production down 50% before cleaning . . . AFTER silica removal: No boiler tube failures; no sandblasting; boilers and turbines operate 12 months between scheduled cleanings at maximum capacity and efficiency

ONE OF the leading manufacturers of paper bags in the south, Southern Advance Bag & Paper Co., at Hodge, Louisiana, has a daily steam production average of 9,350,000 lb from 9 boilers serving 5 turbines generating 12,000 kw, a number of turbine-driven auxiliaries and turbines operating paper machines.

Silica reduction in boiler feedwater has achieved impressive results in these power plant operations, and the previous record presents a striking contrast with current operations. In 33 months of operation, for example, prior to starting the silica reduction process, there were 57 boiler shutdowns, totaling 834 boiler hours of unscheduled outages. Prior to silica reduction, it was necessary to open turbines for sand blasting every four months, a loss of 18 to 20 turbine hours a year. At the same time, power production dropped off as much as 50 per cent during the last two or three weeks of the customary four-months run.

Amount of Silica Reduction

An analysis of 13 raw water samples taken over a period of 3 years, Table I, showed an average silica content of 43.6 ppm, ranging from a low of 30 ppm to a high of 57 ppm.

With the introduction of an Allis-Chalmers product known as Silimite, a silica reduction of 94 per cent has been achieved. With the softener operating at 100 per cent of capacity, records of treated water, Table II, now show a low silica content of 0.8 ppm, a high (at a time of extreme softener overloading) of 8.0 ppm, with an average of 2.7 ppm.

The contrast in feedwater quality, particularly as to silica content, is strikingly seen in typical analyses of "before" and "after" periods, Table III.

Comparison of the samples analyzed before and after external silica reduction was started, Table IV, indicates that, in the latter case, blowdown requirements are virtually half those of the former. But the silica content of the boiler water is still less than half of what it was before the external silica reduction was inaugurated.

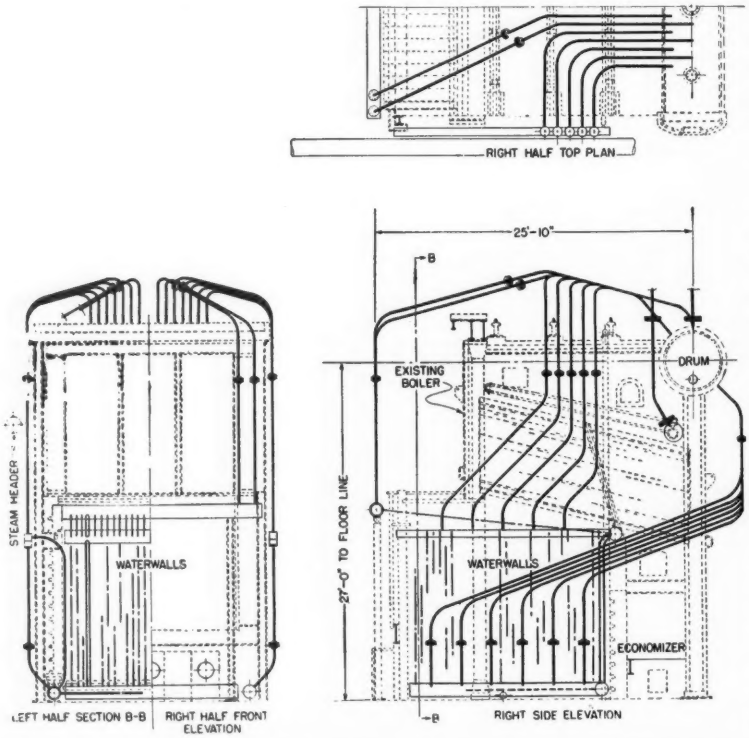


Fig. 1. How water walls and circulating headers and downcomers were applied to existing boilers Nos. 1 to 4, according to design by Chief Engineer D. G. Cooper and Henry Vogt. Machine Co. Circulation from lower side wall headers through curved floor tubes to lower rear header

Feedwater Treatment and Heating

Water for boiler feed is obtained from two company wells and delivered to a concrete reservoir, from which it is pumped through the oil and air coolers before being treated in the 24,000 gph hot process softener and filtered through three 10 ft diameter Anthrafilt filters. The filtered water is transferred to the "surge tank", where it is mixed wi the mill condensate coming from the surface condensers, paper machines and the first effect of several evaporators. This mixture is pumped to the feedwater heaters, from which it flows to the boiler feed pumps.

The reaction chamber of the softener is 12 ft in diameter by 30 ft high on the straight side and is equipped with a vent condenser, raw

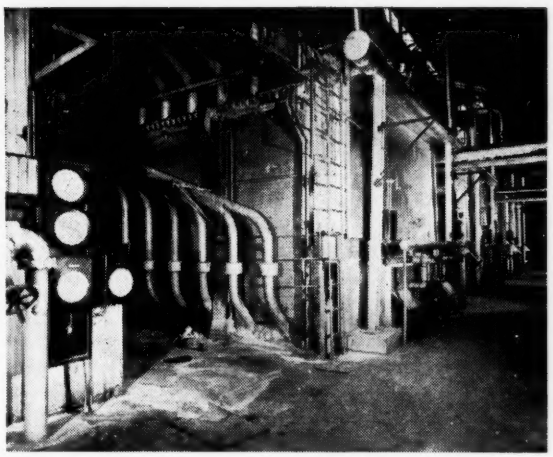


Fig. 2. View of boilers Nos. 1 to 4 at Southern Advance, showing headers and downcomers for water wall system of Fig. 1

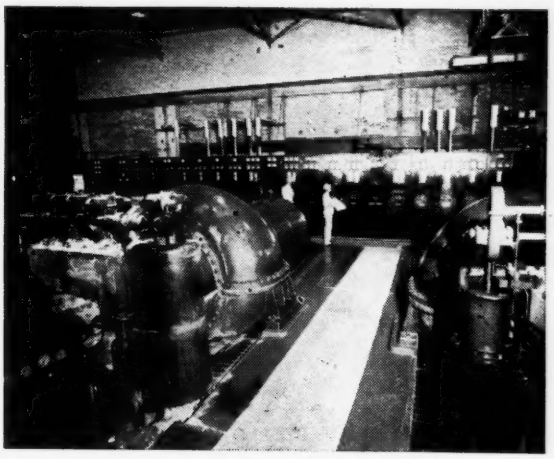


Fig. 3. View in main turbine room at Southern Advance, which contains five turbine-generator units totaling 12,000 kw capacity

water spray nozzle, vacuum breaker and loop seal.

In order to secure more effective results, the softener is operated at 230 F, and a portion of the sludge is recirculated at the rate of approximately 5 per cent of the quantity of raw water to be treated. The sludge recirculating pump receives its suction from the bottom of the sludge cone and discharges into the top of the reaction chamber. The available raw water (See Table I) requires no soda ash for softening, and the lime requirement is supplied by Silimite.

Accurate proportioning of this chemical is accomplished by an electro-magnetic proportioner, Fig. 5, mounted on top of the chemical mixing tank. Electrical impulses received from a contact head attached to the raw water meter actuate the proportioner in direct proportion to the water flowing to the softener. With each meter contact, the proportioner lowers a swing takeoff pipe into the chemical solution tank a definite unvarying distance, thus permitting a precise dosage of Silimite to flow into the pump suction tank, from which it is delivered to the top of the softener.

Chemical Requirements and Control

The Silimite requirement approximates 100 ppm. Sludge cone blowdown is regulated so as to carry an optimum concentration of sludge, which is checked at one hour intervals. The filters are normally backwashed each 12 hr with treated water taken from the outlet of the reaction tank, the backwash effluent being returned to the top of the softener.

Softener operation is controlled by tests for hardness, phenolphthalein and methyl orange alkalinities and soluble silica, which are run every 4 hr. The chemical charge is adjusted so as to maintain a 2P-MO reading in the softener effluent of 45 to 55 ppm. The raw water is tested for hardness, alkalini and silica every 24 hr.

Boiler feed makeup requirements normally approximate 50 per cent. To compensate for the residual hardness in the boiler feed and to provide for satisfactory conditioning of boiler sludge, a polyphosphate and an organic dispersive are used as supplementary treating chemicals. These are sludge-fed through the boiler feed line at 4-hr intervals.

Boiler water samples are tested every 8 hr for alkalinities, chlorides, silica and excess phosphate. Control limits call for maintaining a phosphate residual of 40-50 ppm in all boilers. The blowdown, which approximates 4 per cent, is regulated so as to carry 170-180 ppm of chlorides as sodium chloride in the boilers at the main power plant and the bark burners, but this limit is set at 100-120 ppm in the recovery units.

Results of Silica Reduction

In contrast with the costly record of boiler and turbine maintenance before adopting Silimite, today the Southern Advance power plant is operating virtually without unscheduled maintenance. No tube failures have been reported since silica reduction measures have been taken (compared with the replacement of 133 tubes and welding of 2 in 33 months previous), and the boilers have operated at maximum ratings and efficiency for a minimum of 12 months between scheduled cleaning.

Instead of valuable turbine downtime lost, added to expensive sand blasting, assembly time and the cost of purchased power, turbines are now operating at least 12 months between scheduled inspections, and no sand blasting or cleaning is required.

Silica reduction has provided a steam of excellent quality and, at the same time, efficiency of this power plant is maintained at the rated capacity.

There are three boiler rooms at Southern Advance. The main power plant is equipped with 5 boilers: 4 Walsh and Widener Combustion Engineering Co. units and one B & W boiler. All 5 are sectional-header, straight-sloping-tube, single-cross-

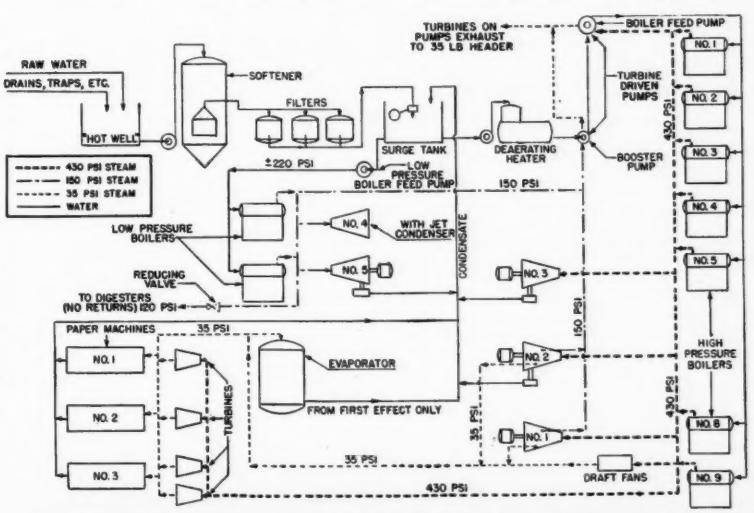


Fig. 4. Diagram of water-steam cycle, showing details of the water treatment system and the connections of three steam pressure systems for 450 psi, 150 psi and 35 psi

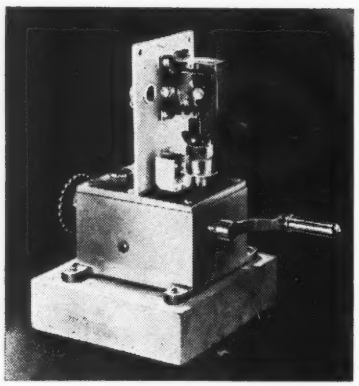


Fig. 5. View of the electro-magnetic proportioner that feeds chemical for silica removal in water softening system

drum design. Boiler Nos. 1, 2, 3, and 4 are provided with waterwalls of an unusual design, Figs. 1 and 2, developed by D. G. Cooper, chief engineer at Southern Advance, in collaboration with the Henry Vogt Machine Co., Inc. Boiler Nos. 1, 2, 3, and 4 are of riveted-drum construction, equipped with Foster Wheeler economizers and steam purifiers. The drum in boiler No. 5 is welded and provided with baffles in lieu of a steam purification device. This unit contains a B & W economizer and superheater. The blowdown is continuous, with the blowdown line coming from the bottom of the rear sectional header.

Boiler Nos. 1, 2, and 3 are individually rated at 22,500 lb per hr while Nos. 4 and 5 each have a designed capacity of 30,000 lb per hr. At a normal rating of about 200 per cent steam production in the main power plant is approximately 271,000 lb per hr. The boilers are gas-fired and operated at 430 psi, with 100 deg superheat.

Two Elliott deaerating tray type feedwater heaters operate in parallel. Steam for feedwater heating is furnished from the 35-psi steam header, and heater temperatures are held at 212 F or slightly higher.

Bark-Burning and Recovery Boilers

The bark-burning boilers consist of two Erie City vertical type two-drum units, with riveted drums, and operate at 150 psi. Neither is provided with a superheater, economizer, or steam purifier. Boiler No. 1, which has no waterwalls, is designed for 17,000 lb per hr, and boiler No. 2, with waterwalls, is designed for 20,400 lb per hr. These units are normally operated at 150 per cent rating. The bark-burners also have continuous blowdown. Water for these boilers comes from the main power plant, where it is treated through the hot process softener. Total steam production from these bark burners is approximately 25,000 lb per hr.

Two B & W recovery boilers, burning "black liquor" are operated at 435 psi. Boiler No. 8 of this group is of sectional-header design, with riveted drums and cyclone separators, but has no superheater. The designed capacity of this boiler is 25,000 lb per hr. Unit No. 9 is a two-drum B & W Tomlinson boiler with welded drums, containing conventional baffles in lieu of any steam purification devices, and operates with about 150 deg of superheat. This boiler is designed for 65,000 lb per hr. Both boilers operate from 150 to 180 per cent rating, are equipped with waterwalls and continuous blowdown systems, but neither has an economizer section. They are supplied with treated water from the main power plant.

The total daily steam production averages 9,350,000 lb, consisting of 6,750,000 lb from the main power plant, 2,000,000 lb from the recovery boilers and about 600,000 lb from the bark-burners.

Power Generating Equipment

Power generating equipment consists of five turbine generators. Of these, three General Electric units operate at 430 psi throttle pressure, one operating full-condensing, one non-condensing with extraction at 150 psi and 35 psi, while the third operates part condensing with extraction at 150 psi and 35 psi. A fourth, 150-psi General Electric unit, operates full condensing. The fifth is a 150-psi Westinghouse unit equipped with a low-level jet condenser and is used only in an emergency. Total generating capacity is 12 000 kw.

Auxiliaries

The three paper machines are equipped with Terry turbines. No. 1 machine has a single-stage, 250-hp booster unit and No. 3 has two of the same type, all operating at 430 psi and exhausting into the 35-psi header, which in turn provides steam for the paper dryers. Machine No. 2 is driven by a 600-hp turbine of the same design, also exhausting into the 35-psi header.

The induced and forced draft fans on boiler No. 9 are turbine-driven, the

(Continued on page 120)

Table I. Analysis of raw water, Southern Advance plant. Average of 13 samples, April 1944 to March 1947

	PPM
Total Hardness ($CaCO_3$)	28.3
Total Alkalinity "M" ($CaCO_3$)	86.4
Sodium Alkalinity	58.1
Calcium (Ca)	7.4
Magnesium (Mg)	2.0
Sodium (Na)	43.5
Silica (SiO_2)	43 6
Bicarbonate (HCO_3)	104.8
Sulfate (SO_4)	16.
Chloride (Cl)	10.8
Nitrate (NO_3)	1.5
pH value	7.3

Table II. Analysis of treated water, Southern Advance plant. Average of 14 samples, August 1944 to February 1947

	PPM
Hardness ($CaCO_3$)	9.9
"P" Alkalinity ($CaCO_3$)	51.7
"M" Alkalinity ($CaCO_3$)	65.1
Sodium Hydroxide (NaOH)	31.8
Sodium Carbonate (Na_2CO_3)	16.6
Sodium Chloride (NaCl)	13.6
Sodium Sulfate (Na_2SO_4)	2.9
Silica (SiO_2)	2.7
pH value	10.2

Table III. Analysis of feedwater, at Southern Advance plant, for periods before and after silica treatment was instituted. All values in parts per million

	Parts per Million	
	Before Average of 9 Samples May 1941 - March 1943	After Average of 16 Samples August 1944 - February 1947
Hardness ($CaCO_3$)	20.4	6.1
"P" Alkalinity ($CaCO_3$)	0	17.1
"M" Alkalinity ($CaCO_3$)	45.5	34.6
Sodium Hydroxide (NaOH)	0	5.1
Sodium Carbonate (Na_2CO_3)	0	15.6
Sodium Chloride (NaCl)	7.3	6.5
Sodium Sulfate (Na_2SO_4)	13.2	12.7
Silica (SiO_2)	26.5	4.4
pH Value	6.8	9.0

Table IV. Analysis of boiler water, at Southern Advance plant, for periods before and after silica treatment was instituted. All values in parts per million

	Parts per Million	
	Before Average of 53 Samples May 1941 - June 1943	After Average of 23 Samples April 1944 - February 1947
Hardness ($CaCO_3$)	0	0
"P" Alkalinity ($CaCO_3$)	268	502
"M" Alkalinity ($CaCO_3$)	314	588
Sodium Hydroxide (NaOH)	178	326
Sodium Carbonate (Na_2CO_3)	70	143
Sodium Chloride (NaCl)	91	149
Sodium Sulfate (Na_2SO_4)	180	342
Sodium Phosphate (PO_4)	23.7	39.5
Silica (SiO_2)	254	112
Total Dissolved Solids	796.7	1111.5
pH Value	10.9	11.5

Save Fuel With Better Heat Cycles

For industrial plants, you can quickly determine fuel savings resulting from use of higher pressure and temperature power plant heat cycles, by using two simple charts and without laborious calculations . . . Where process steam is needed, condensing and non-condensing extraction turbines yield fuel savings, important as fuel costs increase... Power plants for 400 and 600 psi, 750 F compared with 100 to 200-psi plants, all supplying process steam at 5 to 100 psi

By S. D. FULTON
Central Station Steam Engineer
Steam Division, Westinghouse Electric Corp.

STEADILY-INCREASING fuel costs must necessarily be reflected in an ever-widening interest in the savings in fuel consumption which can be attained by more efficient heat cycles. Unfortunately, comparison of plant heat balances for different heat cycles involves calculations that are time consuming and require reasonably accurate knowledge of quantities, temperatures and pressures, which frequently are not available in industrial power plants. Fortunately, however, it is possible to obtain a close comparison of the performance of various power plant heat cycles without arduous calculations simply by eliminating those items common to both cycles and considering only the duty to be performed; namely, to provide a given quantity of electrical energy and a given quantity of process steam at a specified pressure.

With this objective in mind, two charts, Figs. 5 and 6, which are reasonably easy to use and which require a minimum of data, have been prepared. They show the relative fuel consumption of various types of industrial power plants.

Figure 5 chart compares the performance of a high-pressure, condensing, single-automatic-extraction turbine power plant cycle with a low-pressure, condensing, single-automatic-extraction turbine power plant cycle. Figure 6 compares the performance of a high-pressure, condensing, single-automatic-extraction turbine power plant cycle with a low-pressure, straight condensing turbine power plant cycle, in which the process steam pressure is obtained by reduction from boiler pressure. For the higher-pressure heat cycles, initial conditions of 400 psig, 750 F and 600 psig, 750 F have been selected since these are widely accepted conditions for industrial power plants. The lower pressure heat cycles cover a range from 100 to 200 psig dry and saturated. Process steam pressures cover a range from 5 to 100 psig.

Details of Heat Cycles Compared

Figure 1 is a flow diagram for the higher-pressure heat cycles and includes two stages of feed heating. The final feedwater temperature will depend on the extraction pressure. Steam conditions at the turbine throttle will be either 400 psig, 750 F or 600 psig, 750 F. Any extraction pressure from 5 to 100 psig can be covered. The turbine itself is of the condensing, single-automatic-extraction type, Fig. 4. The flow diagram for the lower-pressure heat cycles, where a condensing, single-automatic-extraction turbine is used, is shown in Fig. 2. The second stage of feedwater heating has been omitted and the final feed temperature will be 210 F in all cases. The performance of Fig. 1 cycle is compared to that of Fig. 2 in the chart Fig. 5.

The flow diagram for the low-pressure heat cycle, with a straight condensing turbine and process steam taken through a reducing valve, is shown in Fig. 3. Only one stage of feedwater heating is used and the final feedwater temperature is 210 F. The performance of the cycle of Fig. 1 is compared to that of Fig. 3 in the chart Fig. 6.

Allowances in Constructing Diagrams

In the construction of Figs. 5 and 6, corrections have been made for the difference in available heat, above the heat of the liquid at the process steam pressure, between the process steam from the low pressure and the high pressure turbines. In addition, corrections have been made to the process steam quantities for the high-pressure

(Text continued on page 58)

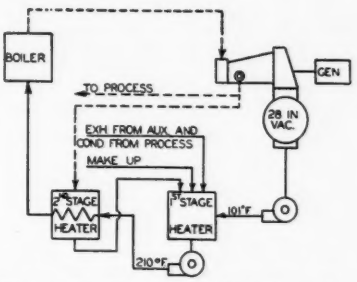


Fig. 1. Simplified power plant steam flow diagram for condensing, single-automatic-extraction turbine, with two stages of feedwater heating

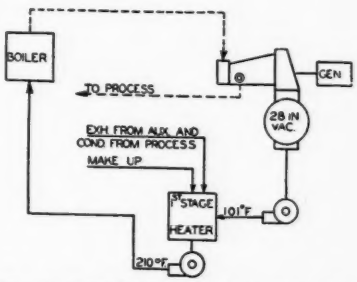


Fig. 2. Simplified power plant steam flow diagram for condensing, single-automatic-extraction turbine, with one stage of feedwater heating

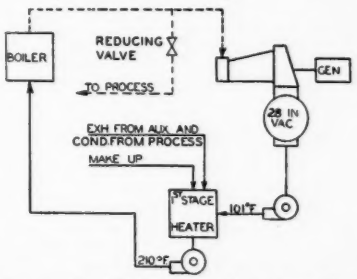


Fig. 3. Simplified power plant steam flow diagram for straight condensing turbine, with one stage of feedwater heating. Process steam supplied by reducing valve

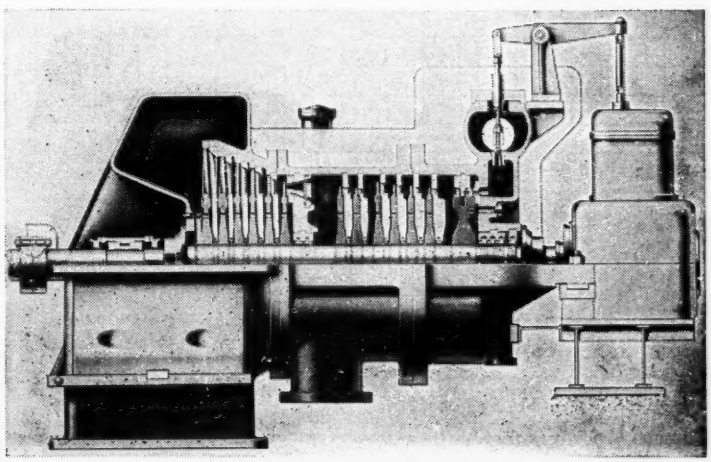


Fig. 4. Longitudinal assembly of typical condensing, single-automatic-extraction turbine

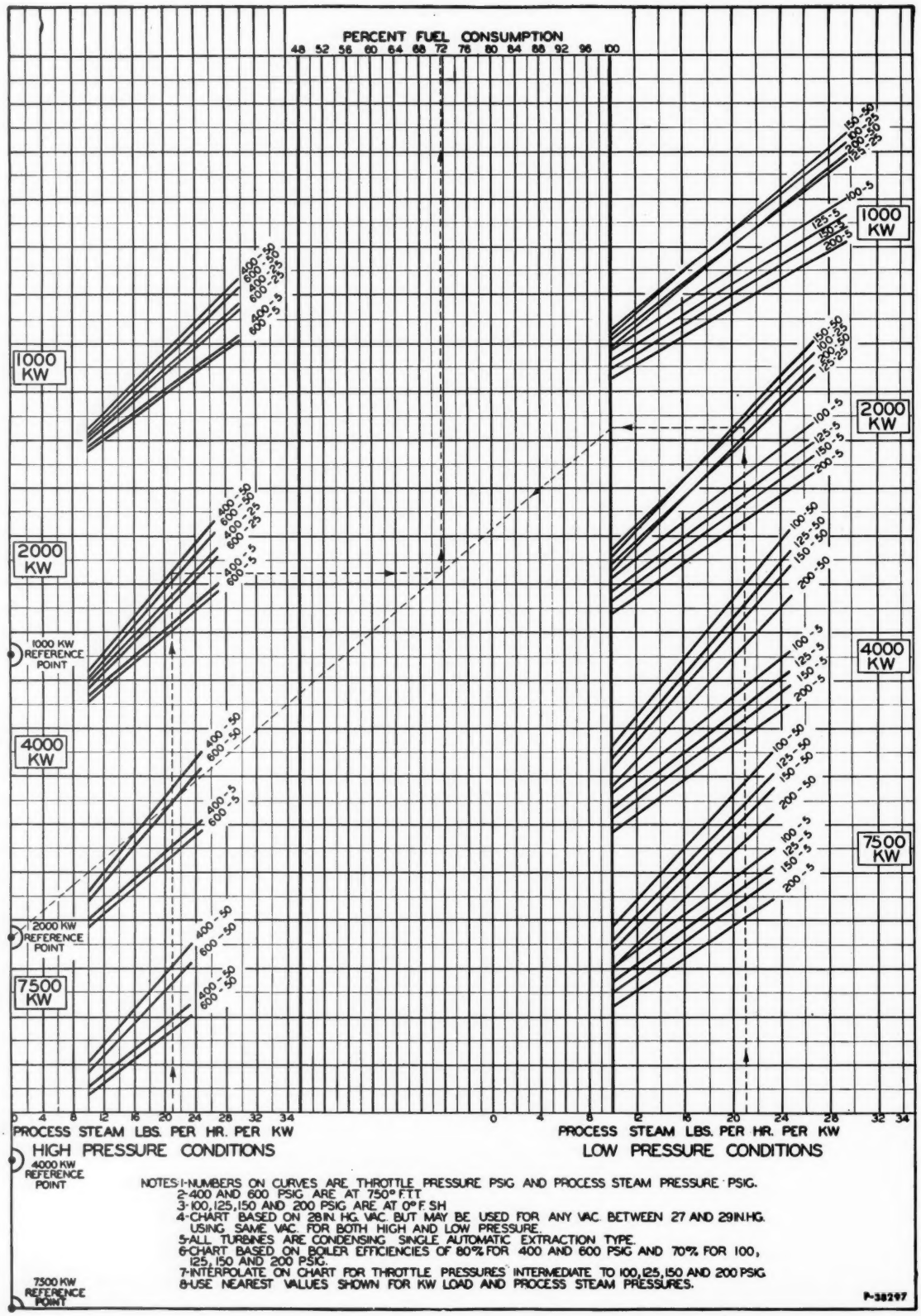

PERCENT FUEL CONSUMPTION
48 52 56 60 64 68 72 76 80 84 88 92 96 100
1000 KW
2000 KW
4000 KW
7500 KW
1000 KW REFERENCE POINT
2000 KW REFERENCE POINT
4000 KW REFERENCE POINT
7500 KW REFERENCE POINT
PROCESS STEAM LBS. PER HR. PER KW
HIGH PRESSURE CONDITIONS
LOW PRESSURE CONDITIONS
NOTES: 1-NUMBERS ON CURVES ARE THROTTLE PRESSURE PSIG AND PROCESS STEAM PRESSURE PSIG.
2-400 AND 600 PSIG ARE AT 750° F.T.T.
3-100, 125, 150 AND 200 PSIG ARE AT 0° F. SH.
4-CHART BASED ON 28 IN. HG. VAC. BUT MAY BE USED FOR ANY VAC. BETWEEN 27 AND 29 IN. HG. USING SAME VAC. FOR BOTH HIGH AND LOW PRESSURE.
5-ALL TURBINES ARE CONDENSING SINGLE AUTOMATIC EXTRACTION TYPE.
6-CHART BASED ON BOILER EFFICIENCIES OF 80% FOR 400 AND 600 PSIG AND 70% FOR 100, 125, 150 AND 200 PSIG.
7-INTERPOLATE ON CHART FOR THROTTLE PRESSURES INTERMEDIATE TO 100, 125, 150 AND 200 PSIG.
8-USE NEAREST VALUES SHOWN FOR KW LOAD AND PROCESS STEAM PRESSURES.
P-38297

Fig. 5. Comparative performance of high and low-pressure condensing, single-automatic-extraction turbine power plant cycles

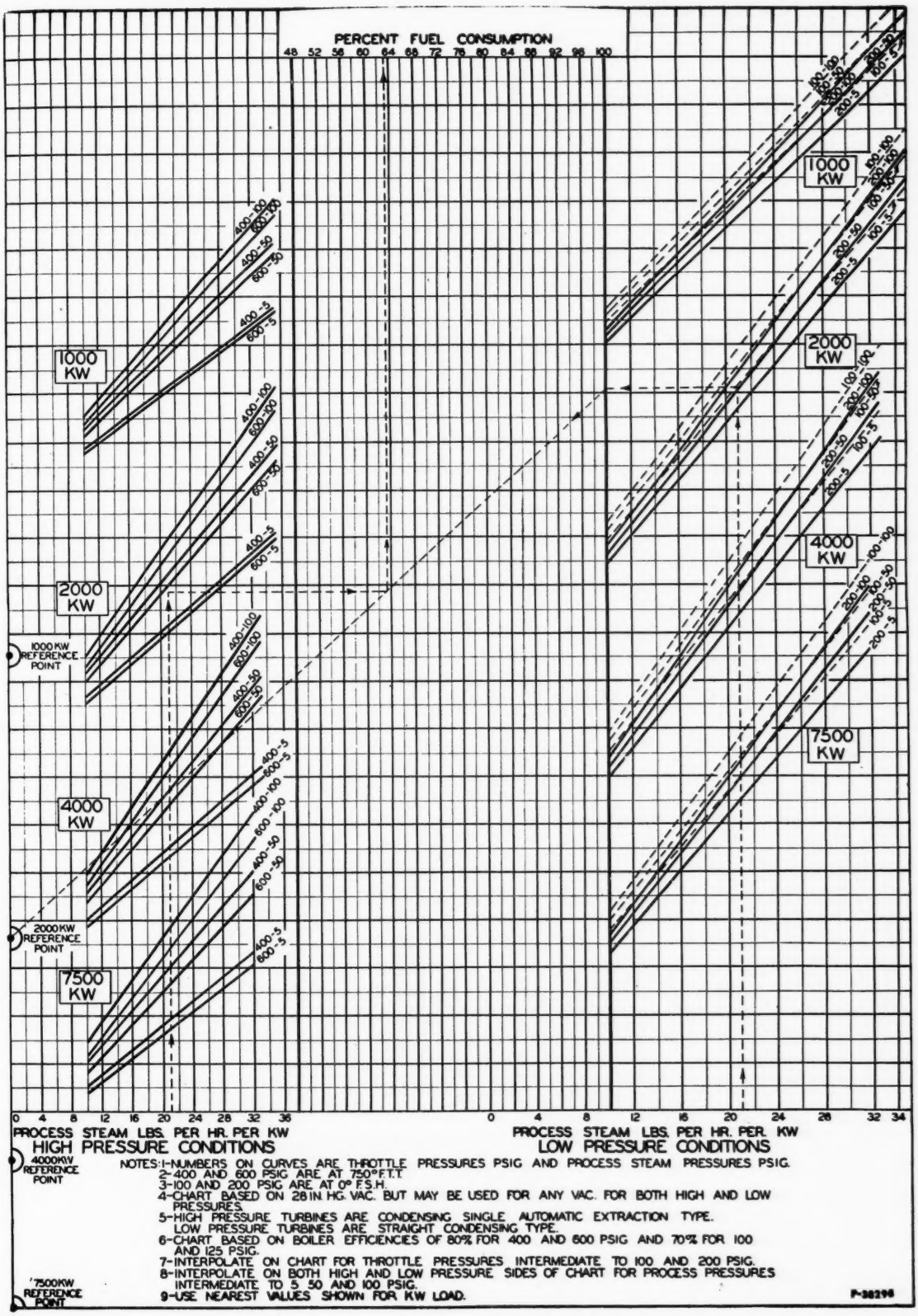

PERCENT FUEL CONSUMPTION
48 52 56 60 64 68 72 76 80 84 88 92 96 100
1000 KW
2000 KW
4000 KW
7500 KW
1000 KW REFERENCE POINT
2000 KW REFERENCE POINT
4000 KW REFERENCE POINT
7500 KW REFERENCE POINT
0 4 8 12 16 20 24 28 32 36
PROCESS STEAM LBS. PER HR. PER KW
HIGH PRESSURE CONDITIONS
0 4 8 12 16 20 24 28 32 34
PROCESS STEAM LBS. PER HR. PER KW
LOW PRESSURE CONDITIONS
NOTES: 1-NUMBERS ON CURVES ARE THROTTLE PRESSURES PSIG AND PROCESS STEAM PRESSURES PSIG.
2-400 AND 600 PSIG ARE AT 750°F.T.T.
3-100 AND 200 PSIG ARE AT 0° F.S.H.
4-CHART BASED ON 28 IN. HG. VAC. BUT MAY BE USED FOR ANY VAC. FOR BOTH HIGH AND LOW PRESSURES.
5-HIGH PRESSURE TURBINES ARE CONDENSING SINGLE AUTOMATIC EXTRACTION TYPE.
LOW PRESSURE TURBINES ARE STRAIGHT CONDENSING TYPE.
6-CHART BASED ON BOILER EFFICIENCIES OF 80% FOR 400 AND 600 PSIG AND 70% FOR 100 AND 125 PSIG.
7-INTERPOLATE ON CHART FOR THROTTLE PRESSURES INTERMEDIATE TO 100 AND 200 PSIG.
8-INTERPOLATE ON BOTH HIGH AND LOW PRESSURE SIDES OF CHART FOR PROCESS PRESSURES INTERMEDIATE TO 5 50 AND 100 PSIG.
9-USE NEAREST VALUES SHOWN FOR KW LOAD.
P-38298

Fig. 6. Comparative performance of high-pressure, condensing, single-automatic-extraction turbine and low-pressure straight condensing turbine power plant cycles

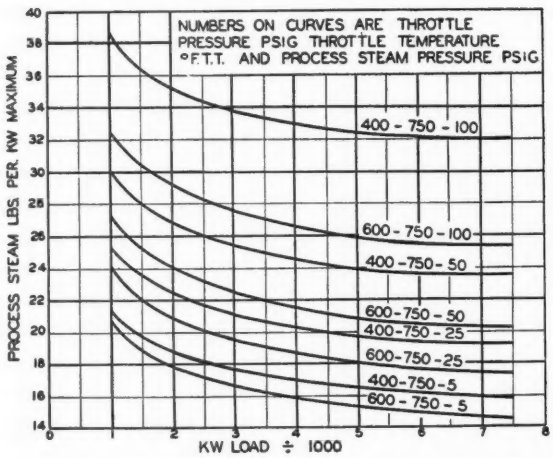

NUMBERS ON CURVES ARE THROTTLE PRESSURE PSIG THROTTLE TEMPERATURE °F.T.T. AND PROCESS STEAM PRESSURE PSIG
PROCESS STEAM LBS. PER KW MAXIMUM
KW LOAD ÷ 1000
400 - 750 - 100
600 - 750 - 100
400 - 750 - 50
600 - 750 - 50
400 - 750 - 25
600 - 750 - 25
400 - 750 - 5
600 - 750 - 5

Fig. 7. Maximum process steam pounds per hour per kilowatt for condensing, single-automatic-extraction turbine, with initial steam conditions of 400 or 600 psig and 750 F

(Text continued from page 55)

heat cycles, to provide the steam necessary for feedwater heating in the second-stage feedwater heater.

Figure 7 gives maximum pounds of process steam per hour per kilowatt that can be obtained for any given set of conditions for the high-pressure cycle. At this process flow, only the steam required to cool the exhaust end blading is flowing to the condenser. Under this condition, the cycle is approximately equivalent to one with a non-condensing turbine and Fig. 5 may be used for determining the comparative performance of a high-pressure non-condensing turbine cycle with a low-pressure, condensing, single - automatic - extraction turbine cycle. It should be noted that, under the same condition of process steam lb per hr per kw, the low-pressure turbine will not be extracting the maximum quantity when the high-pressure turbine has reached its limit. This is due to the lower available energy from inlet conditions to extraction pressure.

Figure 6 may be used similarly for a comparison of the performance of a high-pressure non-condensing turbine cycle and a low-pressure straight condensing turbine cycle with process steam obtained by reducing valve.

Changes in Boiler Efficiency and in Vacuum

Figures 5 and 6 are based on boiler efficiencies of 80 per cent for the new high-pressure cycles and 70 per cent for the old low-pressure cycles. The results obtained may be readily converted to any desired boiler efficiency. For example, if the percentage fuel consumption from Fig. 5 is 70 and a high-pressure boiler efficiency of 85 per cent is required, then the new per cent fuel consumption is $70 \times 0.8 \div 0.85 = 65.8$ per cent. Or, if 72 per cent low-pressure boiler efficiency is required, then the new per cent fuel consumption is $70 \times 0.72 \div 0.70 = 72$ per cent.

The charts are based on 28 in. Hg vacuum, but changes to other values will not cause errors of appreciable magnitude provided the same vacuum is used for both the high and low pressure cycles.

Four loads in kilowatts (not turbine capacities) are shown on the charts and, while interpolation between values can be made by separately finding the result of each load, such interpolation is not necessary for the degree of accuracy expected. Interpolation for kilowatt load cannot be made directly on the charts.

Effect of Approximations

Interpolation on Fig. 5 for process steam pressure is not necessary, since the error produced by using the nearest value is not significant. However, interpolation for throttle pressure on the low-pressure side of the chart should be made, since the error produced is appreciable.

On Fig. 6, interpolation for process steam pressure is necessary on both the high and low-pressure sides of the chart. This may be done either on the chart or, in some cases more conveniently, by determining the percentage fuel consumption for values given on the chart and then interpolating. Interpolation for throttle pressure on the low-pressure side of the chart is also necessary.

The basis on which Figs. 5 and 6 are constructed is pounds of process steam per hour required per kilowatt of electrical energy required. Small variation in this ratio affects the final result so little that it is unnecessary to read the chart closer than the nearest division.

In the use of the charts, several approximations are permitted in the belief that ease in their use more than compensates for the loss of accuracy, since the close approximation is all that is desired. However, it may be pointed out that the percentage of fuel consumption for the higher-pressure cycle decreases as the kilowatt load increases and also decreases as the process steam pressure increases. Variation of the pounds of process steam per hour per kilowatt produces opposite results on Figs. 5 and 6. On Fig. 5, the percentage increases as the pounds of process steam per kilowatt increases and on Fig. 6 the percentage decreases as the pounds of process steam increases. In other words, in Fig. 5 the advantage of the high-pressure cycle decreases as the pounds of process steam per kilowatt increases. In Fig. 6 the opposite result occurs.

In Fig. 5 the highest process pressure shown is 50 psig and, for 1000 and 2000 kw loads, 25 psig is the highest pressure shown for 100 and 125 psig throttle pressure. This is because the extraction pressure is limited for low throttle pressure not only by the throttle pressure — energy available down to the extraction pressure—but also by the size of the unit. However, if the desired process steam pressure exceeds the highest value shown by as much as 60 per cent, the error will not be large.

Now Let's Take an Example

Suppose we have conditions of 2500 kw load and 52,500 lb of process steam per hour with a condensing, single-automatic-extraction turbine with steam conditions at the throttle of 175 psig dry and saturated exhausting to 27½ in. Hg vacuum and a process steam pressure of 35 psig. This gives a ratio of pounds of process steam per hour per kw of 21.0. Now we want to find what percentage of fuel would be required if the turbine inlet conditions were changed to 400 psig, 750 F.

By reference to Fig. 7 we find, by interpolation, that for 400 psig, 750 F and 35 psig extraction pressure at 2500 kw load, we can get approximately 23 lb of process steam per hour per kw maximum. As 21 is less than the maximum permissible the conditions are satisfactory.

Now, using the value of 21 enter the right hand side of Fig. 5 and follow the dotted line to a point on the 2000 kw family of curves half-way between the 150-50 and 200-50 lines. 2000 kw and 50 psig process pressure are the nearest values given on the chart. NOTE that kilowatts is the load and not the rating of the turbine.

Now move horizontally to the intersection of the heavy line dividing the right portion from the center portion of the chart and then draw a diagonal line from this point to the 2000-kw reference point. Using the same value of 21, enter the left side of the chart and move vertically to the 400-50 line in the 2000 kw family of curves. Then move horizontally to the point of intersection with the diagonal line already drawn, and then vertically to the upper scale. Here you read the percentage of fuel consumption, 71.4. That is, the higher-pressure cycle consumes only 71.4 per cent of the fuel consumed by the lower-pressure cycle.

The example shown on Fig. 6 covers the same conditions as that on Fig. 5, the only difference being that the low-pressure turbine is straight condensing and the process steam pressure, 35 psig, is obtained by reducing the boiler pressure from 175 psig to 35 psig. In this case, a double interpolation on the right hand side of the chart, for turbine throttle pressure

(Continued on page 120)

Brush Technique Effective in Condenser Cleaning

THE MOST EFFECTIVE method yet found for cleaning the tubes of steam condensers is an entirely new brushing technique developed by the West Penn Power Co. of Pittsburgh, and which has been tested under varying conditions for a period of over two years.

The new method was worked out cooperatively by L. E. Hankison, Efficiency Engineer of West Penn, and the Pittsburgh Sales Engineer of the Osborn Manufacturing Co. of Cleveland. It not only decreases down or outage time required for this necessary cleaning operation; it also results in prolonged tube life, by eliminating the scratching and roughening of the interior tube surfaces caused by the former cleaning methods.

The new method of cleaning the steam condensers in service in the West Penn System involves the use of specially-designed Nylon brushes approximately four inches in length and ranging from three-fourths of an inch to one inch in diameter, depending upon the inside diameter of the tubes. A special cone-shaped steel washer, slightly smaller than the inside diameter of the tube, is welded to the wire stem at the trailing or pushing end of the brush. The brush is placed in the end of one of the 18 to 24 ft copper alloy tubes, and then "shot" through the tube by water at 200 lb pressure delivered by a specially-constructed, nozzle-like "gun."

The brushing method not only rids the tube of mud and slime—the bane of most power plant engineers' existence—but it also brushes off and washes out all the algae so that a thorough cleaning job is done, and no algae spores are left to help collect further deposits.

The records indicate that since these special brushes have been used, condenser cleaning periods have been much further apart.

Cleaning an ordinary-sized condenser, containing from 6000 to 9000 tubes, is generally completed in two 8-hour shifts. In view of the limited space in which the cleaning men must work, it is usually not practical to use more than two men for the operation, one to plug the brushes into the tubes and the other to follow up with the water gun. A third man sometimes attends the two cleaners and returns the brushes for continued shooting.

Prior to the development of the brushing method, West Penn tried both metal and rubber plugs, and also most of the other practiced methods, to clean their condensers. The metal plugs proved more effective than rubber plugs, which seemed to compact the mud and deposits, making the use of scraper plugs mandatory. However, scratches and roughening by the metal plugs gave algae additional places in which to grow.

West Penn's six steam condensers at its Springdale (Pa.) Station take an average of 650 million gallons of raw water daily from the Allegheny River. There are also six condensers at the older Connellsville Station and several at other smaller stations. Reducing condenser outage time is highly important at this period because of the greatly increased demands for power in the area served by the West Penn Co. Additional generating facilities now being built by West Penn will add one more large condenser this fall, with another the following year.

Fig. 1 (Above). Specially made Osborn nylon spiral brushes are saving the West Penn Power Company, of Pittsburgh, thousands of dollars a year in connection with the cleaning of its condenser tubes. This worker is shown preparing to "shoot" a brush into one of the condenser's 5681 tubes by means of a water nozzle or "gun" carrying water at 200 lb pressure. The head of the condenser has been removed for general overhauling. Ordinarily the workmen approach the cleaning job through a small door in the water box

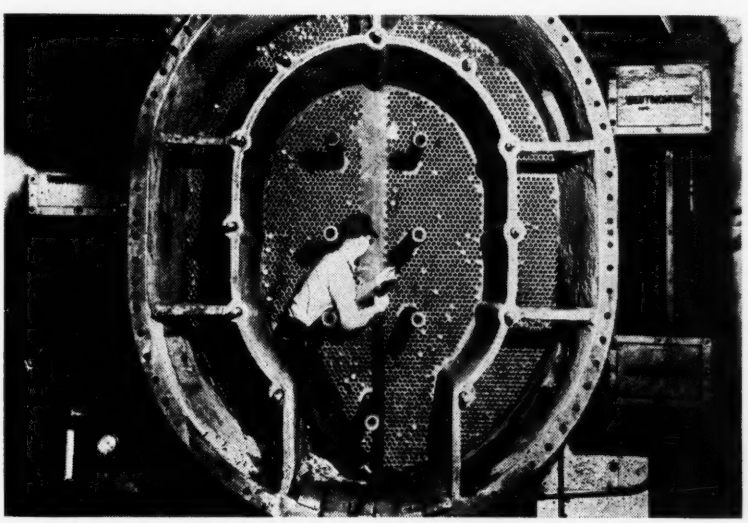


Fig. 2 (Left). Cleaning the 5681 tubes in one of the steam condensers at West Penn's Connellsville (Pa.) station by means of brushes takes approximately two eight-hour shifts by two men. Considerable reduction in equipment outage is obtained since using the brush method, as the effect of the thorough brush cleaning is more "lasting" than that of the scraper or other methods that have been tried

Trends in Modern Feedwater Conditioning Equipment

Part I. Developments in Feedwater Conditioning for Large Boilers. The trend towards larger steam generators has had a definite influence on water treatment methods and equipment. Higher steam pressures and temperatures call for lower total solids, lower alkalinity, and much lower silica. Limitations for hardness, silica, dissolved gasses, etc., as well as the recent developments in techniques for the prevention of scale, carryover, and corrosion, are discussed in detail. The application of these methods will be presented in Part II.

By R. S. APPLEBAUM, President, Liquid Conditioning Corporation

THE TREND towards larger boilers and higher steam pressures has had a marked influence on the design of the necessary external feedwater conditioning plants to keep such boilers free from scale, carry-over and corrosion. In addition, the recognition of silica as a major impurity in water because of the formation of silica deposits in steam turbines has likewise caused changes in the water treatment methods recommended in many cases.

Prevention of Scale

Boiler scale is mainly prevented by reducing the hardness of the water (water softening). The limits of residual hardness to be allowed depend on the boiler pressure and percent of makeup. For pressures up to about 250 psi, a hardness of 1.0 to 1.5 gr/gal (17 to 25 ppm expressed as $CaCO_3$) in the feedwater after dilution by the condensate returns may be tolerated provided there is about 1.0 to 1.5 gr/gal of soda ash also present. When boiler pressures appreciably exceed 250 psi, a hardness approaching zero is usually employed.

To prevent silica deposits in the boilers, it is not only necessary to have low hardness, to prevent calcium silicate scale, but in addition, there should be sufficient sodium alkalinity present so that the ratio of alkalinity to silica exceeds 1 to 1 and, in some cases, 2 to 1. This is to insure the formation of soluble sodium silicate rather than insoluble silica.

To prevent sodium-alumino-silicate (Analcite) boiler scale sometimes encountered in high pressure boilers, it is not only necessary to limit the amount of silica in the boiler salines, but also to limit the amount of aluminum present. Where a water contains excessive amounts of dissolved alumina, some well waters occasionally do, or where colloidal clay is present from which aluminum can be dissolved by high temperatures and high pH values, special treatment to remove aluminum may also be called for.

In addition to reducing hardness, silica and aluminum, it is advisable to build up an excess of phosphate in solution (PO_4) in the boiler saline to act as a chemical barrier against even small amounts of calcium forming

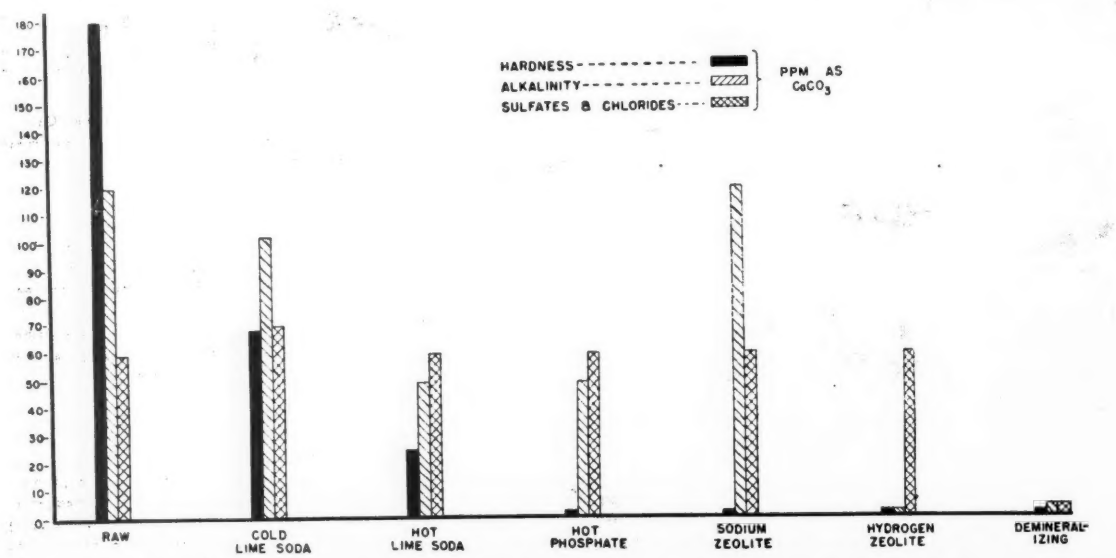


Fig. 1. Graphic results of treating a given water by six different water-conditioning methods. Table III gives results in somewhat greater detail

Table I. ABMA limitations on total dissolved solids present in feedwater to insure the proper quality of steam

Boiler Press. psi	Total Dis'lvd. Solids, ppm
0-300	3500
301-450	3000
451-600	2500
601-750	2000
751-900	1500
901-1000	1250
1001-1500	1000

hard scale. This excess of soluble PO_4, usually 30 to 40 ppm are necessary, forms a small amount of soft calcium phosphate sludge instead of hard scale.

Sludge "Hide-Out"

Such sludge must be kept in suspension in the boiler saline so that it can be blown off. In some cases, a phenomenon known as "sludge hide-out" occurs; this is usually detected by examining the boiler blowoff water. If this blowoff is too clear, one may suspect that the sludge is hiding out somewhere in the boiler and is not being properly dispersed and kept suspended. This suspicion should, of course, be verified by analyzing the feedwater and the blowoffs to establish a sludge balance. Such sludge hide-outs have caused trouble because the sludge accumulates and builds up into a compact hard mass and may cause boiler tubes to become overheated and burn out. To prevent "sludge hide-out" proper chemical "dispedsants" added to the boiler have been known to help, but the main preventive is the very complete elimination of the calcium. Many users of sodium zeolite softeners, which are regenerated when 40 ml of the soft water no longer form a lather with 5 drops of Boutron and Boudet soap solution, now regenerate them sooner so that a lather is formed with only 3 drops of B & B soap. Also by using more than the normal amount of salt, a softer water is obtained from zeolite softeners. Finally, German zeolite plants have been reported softening the water twice. The effluent of the first sodium zeolite unit is passed through a second unit in series. The effluent of the second unit has no detectable hardness. Such softer water obviously reduces the amount of sludge to such negligible quantities that "sludge hide-outs" are eliminated without using supplementary chemical dispersants.

Prevention of Carry-Over

The American Boiler Manufacturer's Association (ABMA) specify that the concentration of total dissolved solids in the water inside the boiler, boiler salines, should not exceed the limits given in Table I in order to insure proper quality of steam.

Table II. Tentative limits of allowable dissolved silica in boiler salines

Boiler & Turb. Op. Press., psi	Max Silica in Salines ppm as SiO_2
250-600	40-50
601-900	20-30
901-1200	10-20
1200-and Over	5-10

Secondly, the ABMA specify that the alkalinity of the boiler salines should not exceed 20 per cent of the total dissolved solids for the same reason.

Thirdly, the ABMA specify that the feedwater should be free from oil, grease or other impurities that may be extracted by ether in a laboratory test. This is to avoid saponifiable matter which causes foaming.

The first two specifications dictate that the designer of water conditioning equipment pay greater attention to the reduction of total solids as the boiler pressure rises and to the reduction of alkalinity in particular.

The third specification calls for the careful removal of oil from condensate that has been formed from oily steam (exhaust from reciprocating units).

Corrosion is usually due to dis-

(Continued on page 122)

Table III. Comparison of operating results of various methods of water treatment

		A HARDNESS IN EFFLUENT PPM AS $CaCO_3$	B ALKALINITY REDUCTION	C TOTAL SOLIDS REDUCTION	D CO_2 IN STEAM	E SILICA IN EFFLUENT	F MUST INFLUENT BE CLEAR	DEGREE OF SKILL TO OPERATE
1)	Sodium Zeolite	0-2	None	None	High if Alk is high	Not reduced	Yes	Unskilled
2)	Sodium Zeolite plus Acid	0-2	Up to 100% if desired	None	As low as desired	Not reduced	Yes	A little more skill
3,4)	Hydrogen Zeolite	0-2	Up to 100% if desired	Reduced with Alk	Same as 2	Not reduced	Yes	Same as 2
5)	Cold Lime Soda	34-85 Depending on excess soda	Reduced by degree removal of $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$	Reduced with Alk	0.44 x Na_2CO_3 excess, usually low	2-3 ppm depending on amount of reagent	No but SiO_2 removal spoiled by very high turbidity	More than 3, 4 or 5
6)	Cold Lime plus Zeolite	0-2	Same as 5	Same as 5	Same as 5	Same as 5	Same as 5	Same as 5
7)	Hot Lime Soda	17-25	More than 5	More than 5	A little lower than 5 and 6	1 - 2 ppm depending on amount of reagent	Same as 5	Same as 5
8)	Hot Lime Soda plus Hot Phosphate	0-2	Same as 7	Same as 7	Higher than 7	Same as 7	Same as 7	Same as 7
9)	Hot Phosphate alone	0-2	Little	Little	Same as 8	None	No	Same as 7
10)	Demineralizing	0-2	Nearly 100%	Nearly 100%	As low as desired	None	Yes	Same as 3,4
11)	Demineralizing plus Anion Unit for SiO_2 removal	0-2	Same as 10	Same as 10	Same as 10	0.2 ppm to 0.5 ppm	Yes	Same as 10

Electrical Contact Troubles—

How to Cope With Them

By **V. E. HEIL**, Metallurgical Research Department,
P. R. Mallory & Company, Indianapolis, Indiana

Few devices in an electric circuit are as simple in construction as a pair of contacts in a switch or circuit breaker or a relay, yet fundamentally few things are more complex in operation. Simple as the opening of a switch may seem, the action is an extremely complicated phenomenon and its understanding involves as great a knowledge of the physics of electrons and atoms as does the operation of an electron tube. It involves theories of ionization, questions of potential gradient, the phenomenon of positive ion bombardment, the photoelectric effect, etc. Indeed, the formation of an arc between a pair of separating electrical contacts is not understood nearly so well as, say, the thermionic emission of electrons from hot cathodes. In this article on electrical contacts, Mr. Heil deos not attempt to discuss fundamental theory of arc formation between contacts but he does consider in great detail the practical aspects of contact operation—why they fail to open at times, the reasons for excessive arcing, problems involved in contact wear, why contacts heat and what to do about it. In short, he considers everything that the practical power plant operator is interested in regarding contacts. Read it; you'll find it interesting and instructive.

THE SUCCESSFUL operation of innumerable types of electrical switching equipment, varying from small sensitive relays to large power circuit breakers, depend upon the reliable operation of electrical contacts. For this wide range of applications, there are a large number of available contact materials consisting of pure metals, alloys, and mixtures or metals made by powder metallurgical methods. In most cases switching equipment is well designed and will give long periods of trouble-free operation when properly used. In cases where they give an unusual amount of trouble, their unreliable operation can usually be traced to excessive overloads or the fact that they are in locations where the atmosphere is very corrosive.

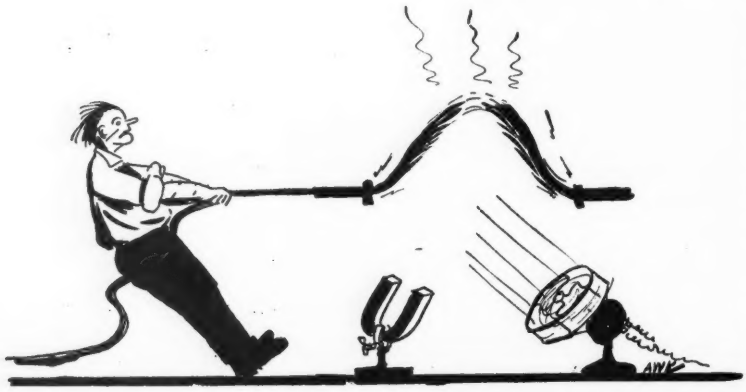
Practically all of the contact failures can be described by one of the following classifications.

1. The contacts failed to open the the circuit.
2. Excessive arcing at the contacts.
3. Excessive wear or erosion of the contact material.
4. Contacts overheated while carrying current.
5. Contacts failed to pass current when closed.
6. Excessive transfer of metal from one contact to the other forming a build-up.

Failure to Open

When the circuit phenomena calls for the contacts to open the circuit and they fail to do so, the failure is usually caused by the contacts welding closed. Many cases of contact welding may be attributed to the fact that the switching device has been handling electrical loads which were considerably above its rating. For example, a switch rated at 10 amp may fail due to the welding of the contacts on a 10 amp lamp load because the inrush current on this load would be approximately eleven times the steady state current or 110 amp and a heavier switch or one designed especially for lamp loads would be indicated. The current for starting a motor is about six times the full load current of the motor and an ample safety factor must be built into the motor starters to prevent contact welding due to the inrush currents.

Welding of the contacts may be caused by misadjustments in the switch. A weak contact spring may allow the contacts to bounce excessively when closing the circuit, and abnormal arcing during the period that the contacts are bouncing may cause the contacts to weld. In most electrically operated switches, there is



In direct current circuits the arc is extinguished by lengthening and cooling the arc and by the use of air blasts and magnetic blow-outs.

an additional movement of the armature or solenoid plunger after the contacts close. This movement is called "over-travel" and usually is used to compress a spring which applies the force that holds the contacts closed. During the opening sequence, an impact force may be applied to the moving contact as a result of this over-travel to aid in the opening of the contacts. If, because of misadjustment of the switch or excessive wear of the contacts, the over-travel is insufficient, the contacts may not open.

There have been cases where faulty operation of control contacts have caused switches to chatter excessively during their closing and opening operations, and excessive arcing during the period of chatter has caused switch contacts to wear excessively and to weld closed.

In some cases where contacts fail to open it will be found that they are held together mechanically by a build-up of contact material on one contact interlocking with the crater in the other contact. This type of failure is more prevalent in direct current circuits where pitting and transfer are more common. Transfer sometimes can be reduced or eliminated by changing to a new contact material. In other cases it may be necessary to alter circuit constants, or insert a polarity reversing switch to periodically reverse the flow of current through the contacts.

Excessive Arcing

Arcing is excessive when it prevents a satisfactory interruption of the current, or causes the contact material to wear at an excessive rate causes excessive oxidation of the contact surfaces, overheating of contacts, or an excessive rate of transfer of the contact material. In power switch gear it is not possible to operate without arcing, however, arcs should be extinguished as soon as possible. In alternating current switch gear the arc is extinguished every time the current passes through a current zero, and in the design of the switch gear steps are usually taken to de-ionize the gap between the contacts to prevent re-ignition of the arc in successive half-cycles. The direct current arc has no self-extinguishing feature such as a current zero and must be extinguished by lengthening the arc and cooling it until it requires a voltage greater than the circuit voltage to maintain it. A popular method of de-ionizing arc gaps is to break them up into a series of gaps by either de-ion arc chambers or a multiplicity of contacts connected in series. Arcs are lengthened by such features as air blasts and magnetic blow-outs. Special arc extinction features are incorporated into the design of certain switch gear and are not simply added as auxiliary equipment.

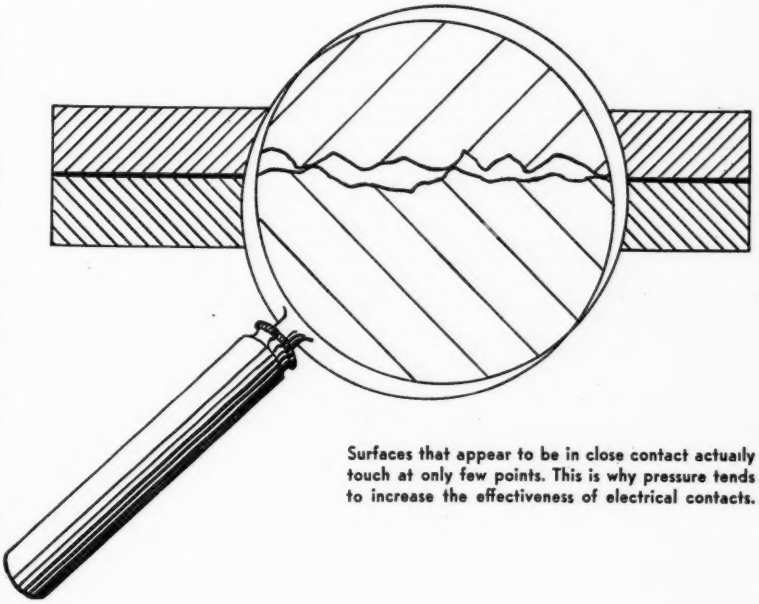
In switching less powerful inductive circuits, the energy released by the inductance when the contacts open causes heavy arcing at the contacts and their rapid deterioration. In many cases, the arcing can be eliminated or reduced to a tolerance value by special arc quenching circuits consisting of resistors or condensers or combinations of the two across the contacts or the inductance. The optimum values of the components of the quench circuits can best be determined by tests under actual operating conditions.

Contact Wear

Abnormal wear of contacts may, in some cases, be due to mechanical conditions, but in most cases, it is caused by arc erosion. Mechanical wear can be reduced by lessening the impact and closing forces and reducing the amount of wiping action.

Arcing heats the surfaces of contacts to very high temperatures and vaporizes metal from the contact surfaces. Part of the metal vapors redeposit on the contacts; however, some of the vapors are lost in space and, as a result, the contacts wear away. Frequently, by increasing the area of the contacts their life may be extended to a reasonable value.

Under conditions of heavy arcing, sizable portions on the contact faces become molten and particles of metal are blasted into space by the large forces that exist at the contact faces due to arcing. When this condition exists with copper or silver contacts, their wear may be so great that they are entirely undependable. In some instances, the performance of the switch may be improved by changing to more arc resisting materials. For example, some contactors show improvement under these conditions by substituting a silver-cadmium oxide contact material for their original fine silver contacts. Some copper contacts make and break the circuit at one portion of the contact surface and move to a different area for carrying the current. Elkonite inserts covering the area that first makes and last breaks the circuit on these contacts have increased their resistance to arc erosion considerably. Elkonite materials are powder metallurgy products wherein high melting point metals, such as molybdenum, tungsten, or tungsten-carbide, are intimately combined with the high conductivity metals, silver or copper, to form a material which has unusual wear resistance under conditions of intense arcing.



Surfaces that appear to be in close contact actually touch at only few points. This is why pressure tends to increase the effectiveness of electrical contacts.

Overheating of Contacts

Heat is generated in an electrical circuit when a current flows through a resistance. All electrical conductors have resistance and there is a certain amount of resistance on any piece of switch gear. The amount of heat generated will vary directly with the resistance, the square of the current, and the length of time that the current flows. The greater amounts of heat will be generated at the points of higher resistance. A large portion of the contact resistance in a switch occurs at the interfaces of the contacts. The resistance is high at this point because only a small portion of the total area of the contact surfaces are actually in contact. The temperature to which the contacts are heated depends upon the rate at which the heat is generated and the rate at which it is carried away by heat conduction and radiation.

Probably the most frequent cause for overheating of contacts is high contact resistance. High contact resistance is usually caused by non-con-

(Continued on page 128)

Improvements in Automatic Rolling-in of Small Tubes

This article describes a method involving a switching and relay circuit which automatically controls the amount to which small tubes are expanded as in the case of condensers and heat exchangers. This arrangement constitutes an improvement over a similar equipment developed in 1942. It is simple and foolproof in its construction and operation and should be of interest to everyone who has occasion to maintain equipment using small tubes.

By E. T. COPE, The Detroit Edison Company*

IN A FORMER PAPER[1] the author of this article and an associate described a new method for expanding the ends of tubes into tube sheets in heat exchangers such as condensers and feedwater heaters. This method employs a novel combination of devices which automatically control the amount to which a tube is expanded. The operator has merely to close and lock the switch in the handle of the motor-driven expander tool, introduce the tool into the tube end, press it home, and hold it in place. The motor stops automatically when the tube has been expanded to the correct amount, and the operator has only to reverse the pressure of his hand on the tool to restart the motor backing out the tool from the tube. In this cycle of operations the driving motor is stopped by the action of the current-limiting switch (called "relay" in the former paper). The operation of this switch opens the circuit to the motor when the current reaches a predetermined value that has been ascertained by tests as that necessary to result in satisfactory expansion of the tube. In making the tests, the switch was adjusted to operate on the lowest current, to the motor, that would produce expanded joints of satisfactory push-out strength.

In the switch, a modified relay described in the previous paper, the full current to the motor passed through the operating coil of the switch. The impedance of the actuating coil of the switch was about 22 ohms which produced a drop of about 20 across the switch. This condition resulted in a marked decrease in the speed of the expander motor as the end of the expanding operation was approached, and seriously delayed the completion of the joint. The switch possessed another serious fault; the mechanism was often erratic in resetting. These two faults, both causing delay in the rapid progress of expanding the tubes, were so serious that a more satisfactory type of current-limiting switch was sought. After several attempts to find a satisfactory current-limiting switch that was available commercially had failed, the switch that is the primary subject of this article was developed. Field experience with this switch in connection with installing 11,000 tubes in a steam condenser —1000 tubes each in three high-pressure feedwater heaters, and 900 tubes in another heat exchanger—has been so satisfactory that it is believed others may wish to share the benefits to be derived from its use.

*Now Associate Professor of Mechanical Engineering, Wayne University, Detroit, Michigan.

[1] "Automatic Uniform Rolling-In of Small Tubes" by F. F. Fisher and E. T. Cope presented at the Semiannual Meeting, Cleveland, Ohio, June 8-10, 1942, of The American Society of Mechanical Engineers.

Description of the New Current-Limiting Switch

The schematic diagram of the new current-limiting switch is shown in Fig. 1. The connections to the auxiliary switch and the motor are indicated. The device consists essentially of two relays and the necessary connections. The 6 v relay having the Contact A is shown at the upper left. This is the key relay because its current to the motor. The degree of operation is controlled by the value of expanding of a tube is fixed by the value of the current necessary to operate this relay.

The current sensitivity of the relay alone is such that it operates on 0.65 amp. The two resistors that parallel the operating coil of this relay are provided in order to allow for adjustment of the operating current range of the device. These resistors also provide means by which a more nearly uniform scale on the rheostat is possible. The current necessary to operate the relay is adjusted by means of a change in the setting of the "25-ohm, 150-watt rheostat," the dial of which is shown in Fig. 2. This voltage drop across this new switch is of the order of 6 v at 1.5 amp to the motor circuit. This small drop in voltage across the switch makes this switch

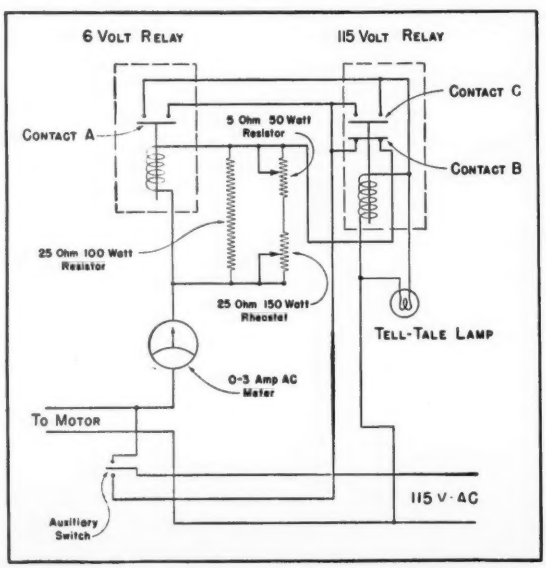


Fig. 1 Wiring diagrams of the new automatic current-limiting switch. The 6-v relay which cuts off the motor is shown at the upper left. The current necessary to operate this relay is adjusted by means of the 25 ohm, 150 watt rheostat.

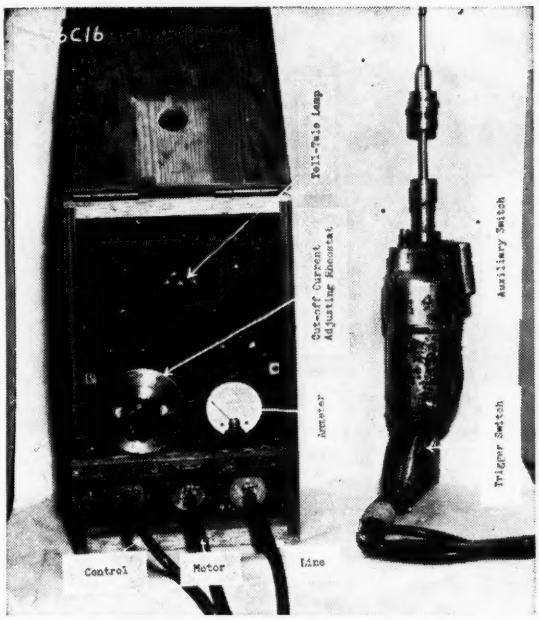


Fig. 2 Condenser tube expanding equipment with the new automatic current-limiting switch.

superior to the older one in that the motor is capable of sustaining a higher speed during the rolling-in of a tube than was possible when the older switch was used.

The second relay, marked "115-volt Relay," shown at the upper right in Fig. 1, has Contact B as well as Contact C. Contact B is the one that opens the circuit to the motor when the current reaches the prescribed value for expanding a tube end. Contact C in this relay closes when Contact B opens. When Contact C is closed, the motor circuit is locked in the open position and the motor cannot be started until the operator exerts a pull on the tool, away from the tube sheet.

During the expanding of a tube end, three separate settings occur in the contacts in the current-limiting switch and the auxiliary switch. These three settings can occur in only one sequence because the auxiliary switch is mechanically interlocked with the axial movement of the expander arbor. Neither can the motor start out in sequence. This is achieved by a spring inside the motor gear case which holds the spindle and the auxiliary switch in the correct starting position. This arrangement makes the equipment "foolproof." The three settings are shown in Fig. 3 and are marked as follows:

(a) Position for starting and backing out
(b) Position for expanding a tube end
(c) Locked position

The details of each of these positions are explained below.

Normal Position for Starting and Backing Out

The value of the starting current of the motor, which is series wound, is several times the maximum value of the running current necessary to expand a tube end, as shown in Fig. 4. Therefore, it is necessary that the motor be connected directly across the source of current when starting it. The positions of the switches and relays during this starting are shown in (a) Fig. 3. The auxiliary switch actuated by the collar on the spindle of the expander motor is in the "out" position. In this position current passes from the 115 v source through the auxiliary switch ("black" contacts "white") to the motor. Current cannot pass through the current-limiting switch because to do so requires that the auxiliary switch shows "white" in contact with "green." This condition is evident when the paths shown in (a) Fig. 3 are examined. The motor starts and the next step is to introduce the expander head into a tube end and proceed with the expanding. It should be noted that the axial position of the spindle for starting is the same as for backing out and in this position, because of the arrangement of gears in the gear case, the expander rotates in a counterclockwise direction. Details on the operation of backing out are described later.

Expanding a Tube End

The expander head is now introduced into the tube end to be expanded. In order to accomplish this, the operator of the tool holds the ex-

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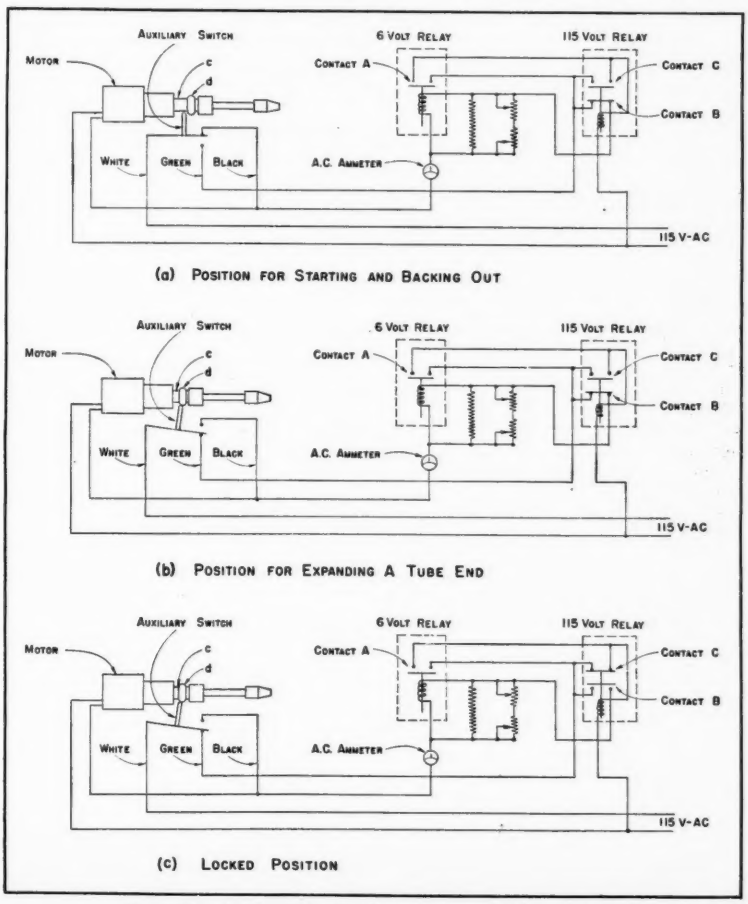


Fig. 3 Electric Circuit for Condenser tube expanding equipment.

ATOMICS

A New Section added to POWER GENERATION to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Military Influence on Nuclear Research

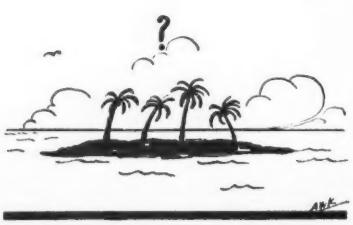
The military importance of atomic energy has a profound influence on the further development of nuclear research. It imposes a distasteful kind of secrecy but at the same time it provides all but unlimited funds for carrying on important nuclear research. Evidence of this fact is provided in the announcement by the U.S. Atomic Energy Commission of the construction of a new 110 ft. cyclotron costing nine million dollars.

By ANDREW W. KRAMER, Editor, Power Generation

ON APRIL 19, the U. S. Atomic Energy Commission issued a brief statement announcing the fact that there had been a test of "an atomic weapon" at the proving grounds of the Commission on Eniwetok Atoll in the Marshall Islands.

Nothing more was disclosed. Neither the date nor the nature of the test was mentioned. The issuance of further information concerning the test, the announcement said, was not permissible at present.

The difference between this test and the Bikini tests, three years ago, is more significant than the average person realizes. Two years ago the Bikini tests were proclaimed to all the world. For days, weeks and months in advance they were played up in a constant stream of publicity, and newspaper men and military and scientific observers from all over the world were invited to view the tests —it was a Roman Holiday. Even the Russians were invited.



What happened at Eniwetok?

But now it is different. The United States is far less magnanimous. True, the Bikini tests disclosed little that had not previously been made public. Those who attended the test, the Russians included, saw or learned nothing that was not already public knowledge. But the gesture of the United States Government in staging the Bikini tests and inviting the foreign representatives was in accord with the general temperament of the times—a feeling of peace. Today that feeling, that hope of peace, has all but vanished.

After the atomic bombs were dropped on the cities of Japan—all that following year a great many people in the world felt that in the atomic bomb we had a weapon of such horrible destructive power that men and nations would at long last recognize the futility of war and bring about some means for stopping it forever. In everything that was said and written that year, the full horror of Hiroshima and Nagasaki was brought home with that in mind. While the Bikini tests were actually conducted for the purpose of determining the destructive effect of atomic bombs on naval vessels, the manner in which the tests were conducted implied a certain amount of international confidence in the establishment of a system of world control of atomic energy. The Barauch Plan presented to the United Nations was also an evidence of our sincere desire to promote world peace.

Now all this has changed. True, the United Nations Assembly still discusses the control of atomic energy, but interest in these discussion is halfhearted. Even while the discussions are going on, each nation is frantically endeavoring to develop or improve whatever atomic assets it may have. No longer are any Smyth Reports issued. No longer is there any general feeling that a third World War can be averted. Quite the contrary; in almost everything that is done or said, plans are being made to wage that third World War. And so, when it became expedient to test out a new "atomic weapon" last month, the test

was conducted under the utmost military secrecy.

What Took Place at Eniwetok?

It is difficult to speculate upon the nature of the test which was conducted in the Marshall Islands last month. Presumably it was an improved type of atomic bomb, but it may have been something else. As is will known, the deep sea test of the atomic bomb, freely discussed at the time of the Bikini tests, was never carried out. In this proposed deep sea test, it was planned to explode an atomic bomb at a depth of several miles below the surface of the ocean. The primary object of this test was to determine what kind of shock waves would be produced and what effect these shock waves would have on naval vessels on the surface.

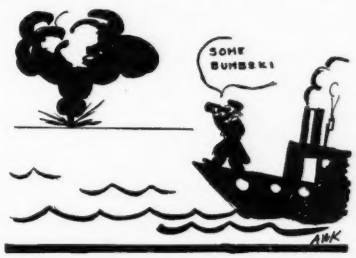
While it is remotely possible that the recent Eniwetok test was a deep sea test[1], it is much more likely that it was a test of a new type of atomic bomb—a bomb of the plutonium type but with a larger or more efficient charge, than those used previously, or it may have been a bomb using some light element reaction such as the lithium hydrogen reaction.

As has been explained in previous articles in this section, when lithium is bombarded with hydrogen the resulting beryllium nucleus[2] is unstable and it instantly splits into two helium nuclei with a release of 17 million electron volts of kinetic energy. Now, of course, the 17 million electron volt energy release from the lithium hydrogen reaction seems small compared to the 200 MEV energy release from the uranium fission reaction of the atomic bomb. But when the energy release, weight for weight, is considered, it will be seen that the lithium hydrogen reaction is more than twice as powerful as the uranium fission reaction. Uranium fission involves 235 weight units, and yields only 200 MEV, less than 1 MEV per weight unit. The lithium hydrogen reaction on the other hand, involves eight weight units and yields 17 MEV, more than 2 MEV per weight unit. It is obvious, therefore, that if the lithium hydrogen reaction could be made to work, it would be very much more powerful than the uranium fission reaction of the atomic bombs exploded at Hiroshima and Nagasaki.

The lithium hydrogen reaction looks attractive, but unfortunately, or perhaps fortunately, it is not brought about as easily as the process may seem on paper, nor as easily as uranium fission in the atomic bomb. Uranium fission is brought about by slow speed neutrons, whereas the lithium hydrogen reaction requires that the hydrogen nuclei strike the lithium nuclei with an energy of at least 150,000 electron volts. In the Cockcroft Walton[3] experiment, this energy is imparted to the hydrogen nuclei or the alpha particles as they are called, by a high voltage accelerator. While the high voltage accelerator does impart the high energies to the alpha particles, so few successful hits are made that less energy is released than is consumed in the process.

How It Might Be Done

This drawback might be overcome. As a substance is heated, the atoms and molecules that make it up begin to move at higher and higher speeds. They not only move at high speed but keep colliding again and again at these high speeds. If a mixture of lithium and hydrogen were heated to a sufficiently high temperature, this thermal agitation would make the hydrogen and lithium atoms bombard each other repeatedly and continuously. If the temperature was high enough, these speeds might actually reach the required 150,000 electron volt energy referred to above. Actually the particles themselves would only have to attain a speed equal to about 75,000 electron volts, because at that speed when a hydrogen atom going one way met a lithium atom going the opposite way, the relative speed of impact would be the required 150,000 volts. If a hydrogen atom missed one of the lithium nuclei, it would keep on colliding with atoms until it struck one with which it reacted.



We even invited the Russians

While this reaction is simple enough to explain, no ordinary method that we have at our disposal can heat material to anything even remotely approaching the 75,000 electron volts ignition temperature, for that temperature is in the neighborhood of 200 million degrees centigrade.

Note that we say, no ordinary method available enables us to reach these temperatures. However, the detonation of a U 235 bomb which, of course, can be started at an ordinary temperature, instantaneously produces a temperature enormously higher than the 200 million degrees required. Thus, if we could combine a U 235 bomb with lithium and hydrogen so that the latter two elements would be heated to the ignition point, the reaction we were looking for would automatically take place. Since both lithium and hydrogen are easily available and cheap commodities and since there is a reasonable chance of success in developing such a bomb undoubtedly a great deal of research is being done in the direction of producing a bomb of the lithium hydrogen type.

There may be many unknown factors involved and it may be far too early to expect the successful development of a lithium hydrogen reaction type of bomb, but it is quite within the bounds of possibility that the recent tests at Eniwetok were along that line. If they were and how successful they were, only time will tell.

To the scientist and to many of the intelligent public, these intensely secret activities are somewhat distasteful. It goes against our naturally democratic instincts, and if it were not for the fact that these measures are taken in the interest of our individual and collective security, we would see to it that they were done away with quickly. However, since we are distrustful of other nations and other nations are distrustful of us, we seem to have no alternative but to engage in the course that we are pursuing.

It is however, an ill-wind that blows nobody good. There is one aspect to this military importance of atomic energy that is in the public peace time interest and that is the fact that we feel it necessary to spend a great deal of money and effort on the development of atomic energy for military purposes. If it were not for the military importance, it is unlikely that the U. S. Atomic Energy Commission would be permitted to promote the expensive scientific research that has recently been authorized If there is one thing that is needed in the further development of atomic energy, it is new fundamental knowledge — new knowledge of the type of forces that prevail in the interior of the nuclei of atoms. Much more needs to be known about nuclear reactions.

The investigation of nuclear forces is no longer a one-man job. It requires the co-operative knowledge and efforts of large numbers of scientists and millions of dollars worth of expensive scientific equipment. Before the war the money to build such scientific apparatus had to come from private sources, from commercial establishments or from endowed foundations, such as the Rockefeller Foundation. The 184-inch cyclotron which was started at the University of California at Berkeley before the war, was financed by the Rockefeller Foundation. This was the largest cyclotron in the world and it was this cyclotron that produced the mesons referred to in these pages last month. This cyclotron is still by far the largest of its kind in the world.

Recently, however, the United States Atomic Energy Commission announced that it would finance the

ATOMICS

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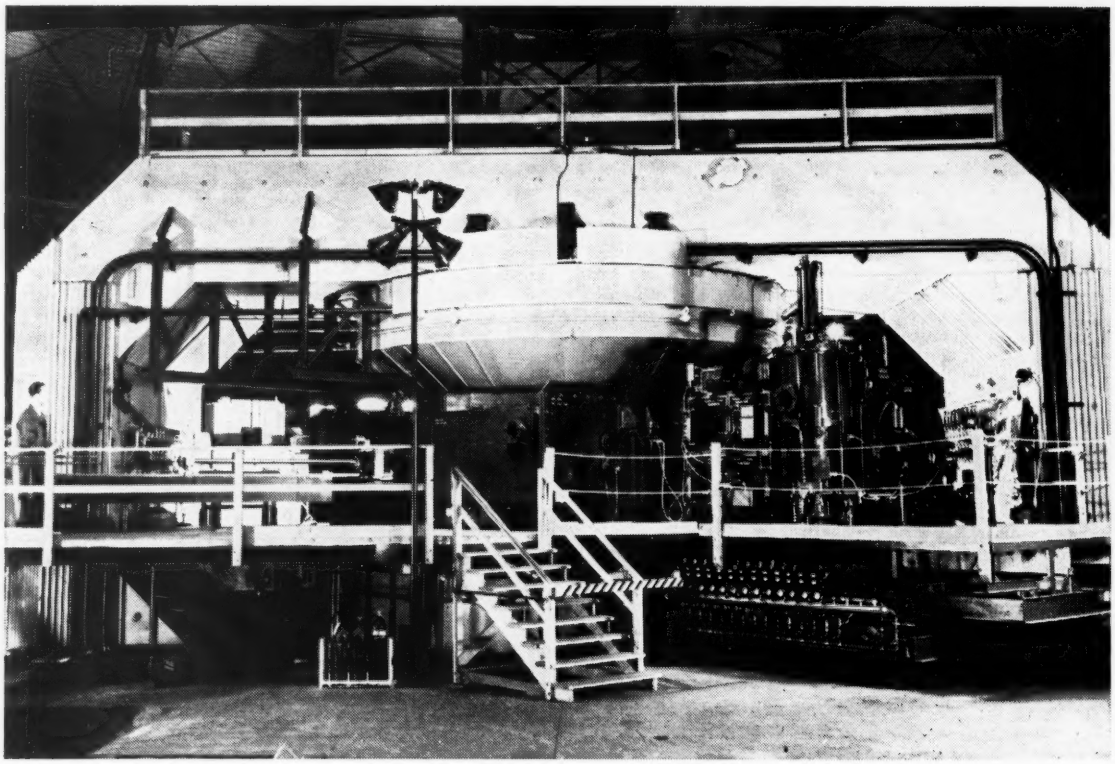
[2] $_1H^1 \rightarrow {}_3Li^7 = {}_4Be^8 = {}_2He^4 + {}_2He^4$ 17MEV

[3] See "Recent Developments in High Energy Physics", Jan. 1948, p 91.



This is the world's largest cyclotron to date but it will be a mere toy compared to the new 110-ft. unit recently authorized by the U.S. Atomic Energy Commission. This is a view of the 184-in. cyclotron at the University of California. Ten times more powerful than any other nuclear accelerator in the world, it fires deuterons of 200 million electron volts, alph particles of 400 million electron volts and, when alterations are made, protons of 350 million electron volts. The huge steel cross piece (another is under the floor) and the two side pieces constitute the yoke of the 4000-ton electro-magnet. (The magnet structure for the proposed 110-ft. cyclotron will weigh 10,000 tons). The huge bowl shaped objects connected to the cross pieces are the coil castings of the electro-magnet. The pillbox between the coil casings is the accelerating chamber. The long steel rod at the left is the "probe", used to insert targets into the chamber for bombardments. Auxiliary equipment at the right foreground is the frequency modulation system. This cyclotron was constructed from an original grant of the Rockefeller Foundation. It is now being operated under the auspices of the Atomic Energy Commission.

construction of a very much larger and more powerful cyclotron than the 184-inch cyclotron at Berkeley. This new cyclotron is to be a 110-foot cyclotron and it also will be constructed at the Radiation Laboratory of the University of California at Berkeley. This machine is so much larger than any other machine now in existence that a discussion of its possibilities lie almost in the realm of fancy; it is impossible even to predict what this instrument may uncover in the years to come. The construction of this new accelerator will take approximately 5 years and its total cost will be about *nine million dollars*. It will be a major tool for basic research in the properties of atomic nuclei.

Important as the peace time use of atomic energy may be in the world, no matter what effect it may have on the future of man, it is quite certain that if military needs did not demand it no such large amount of money would be spent either by the government or by private institutions, purely for scientific research—our politicians would see to that. In the first place, no private institution, either a commercial establishment or a university, could undertake it. Even such an institution as the Rockefeller Foundation could hardly afford to put so much money into the construction of one machine. If the government were to do it, the proponents of free enterprise and private initiative would raise an outcry about government interference with private initiative.

As it is, however, no one, no group or individual can afford to take issue with the U. S. Atomic Energy Commission for its action in authorizing this great research project, since ostensibly it furthers our military knowledge.

Actually, of course, 9 million dollars is a mere nothing—a drop in the proverbial bucket. We have never hesitated to authorize expenditures of anywhere between 60 and 100 million dollars for a single battle ship which can be destroyed in a few minutes in action. Nine million dollars is chicken feed compared to many of the expenditures we made during the war for far less important things, but it is almost bewildering to think of such an amount of money being spent on a device which, after all, is little more than a scientific merry-go-round. This new nine million dollar cyclotron, however, is not the only new project which the Atomic Energy Commission has authorized recently. At the same time that it authorized the construction of this 110-foot cyclotron at Berkeley, it also announced the fact that it will finance the construction of a 30 foot multibillion volt proton synchrotron at the Brookhaven National Laboratory on Long Island. The con-

We spend 80 million dollars for a battleship without batting an eye

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struction of this accelerator, which will be the largest in the East, will take approximately 3 years and its total cost will be about 3 million dollars. Therefore, the combined amount of money to be invested in these two machines will be in the neighborhood of 12 million dollars—all of this for pure research.

Ten Thousand Tons of Steel

With the new 110-foot cyclotron at Berkeley, it is expected that protons will be accelerated to energies in the billion electron volt range. Like the existing 184-inch cyclotron, the new billion volt accelerator will accelerate several kinds of nuclear particles, and also it will combine the operating principles of the cyclotron and the synchrotron. Construction of this great machine will begin this summer or this fall. Experimental work on some of the component parts have already demonstrated that construction of the new machine is practical. This research has been done under the general direction of William Brobeck, Assistant Director of the Radiation Laboratory, whose basic engineering studies prove the feasibility of reaching the billion volt range. While the details of the instrument's operation and design have not been worked out, the general characteristics of the great machine are known. It will have a ring-shaped magnet requiring about 10,000 tons of steel. The radius of the magnet will be 55 feet; its length from the outside limits will be 140 feet; and the magnet will operate from a 5000-kilowatt power source. As protons pass the accelerating electrode point on each trip around the magnet, they will be struck by a high-frequency charge of either 2500 or 5000 volts. With 5000 volts on the accelerating electrode, each particle would make more than 1 million trips around the chamber before reaching 6 billion electron volts. There will be both modulation of the frequency of the accelerating power and modulation of the strength of the magnetic field. Protons will be injected into the accelerating chamber by a subsidiary atom smasher, probably a Van de Graaf generator. As they speed around the chamber, the magnetic field will be adjusted at a strength which will keep protons of that energy in the chamber's orbits. As the particle is accelerated to higher energy, it would normally have a tendency to spiral outward as it does in the conventional cyclotron. However, it is kept in its original orbit by increasing the strength of the magnetic field. As the proton gets to higher and higher energy and thereby begins to lag, the frequency of the accelerating bursts of power on the electrode is slowed down to accommodate the lagging particle. Professor E. O. Lawrence, Director of the Radiation Laboratory under whose supervision the new machine will be constructed, said that the proton with billions of volts of energy, will result in the production of pairs of particles such as mesons rather than only one meson at a time. Other than this, Dr. Lawrence is willing to predict only that new and unexpected nuclear phenomena will be observed and that there will be notable advances in fundamental knowledge.

The construction of the multi-billion volt proton synchrotron at Brookhaven will also yield protons with energy from 8 to 10 billion electron volts. This machine also will produce, under controlled laboratory conditions, high energy protons, the primary cosmic particles which constantly penetrate the earth's atmosphere. By causing these high energy protons to bombard hydrogen atoms, for example, it will be possible to produce heavy and light mesons in the same manner as these particles are made by cosmic rays.[4]

The first known presentation of the idea of a multi-billion electron volt synchrotron was made in 1943 by Professor M. L. Oliphant, an Australian scientist now at the University of Birmingham, England. This early idea was not published at that time, and it only became known in 1947. Meanwhile, there were two independent discoveries of the principle. One by Professor Vecksler, a Soviet scientist, was published in 1945 in the USSR Journal de Phisique. The other by Professor E. McMillan of the University of California, appeared also in the Physical Review.

Dr. Philip M. Morse, director of Brookhaven National Laboratory, stated that the construction of the 30-ft proton synchrotron undoubtedly would lead to broad extension of our present knowledge of the nucleus. As pointed out by Dr. Morse, nuclear physics today is in a position of development which can be compared with that of chemistry 50 years ago. At that time chemists knew a great deal about valences and combining weights of elements, but did not know how the forces acted which made molecular bonds. In the last 50 years this has come to be well understood. In nuclear physics today, we know that atomic nuclei are held together by some new force. We call it nuclear force, and we know that it is not an electrical, chemical or gravitational force and that it is specifically a nuclear phenomena. To study and understand this new force, it is necessary to have instruments which will make or break this force at will under controlled laboratory conditions.

[4]See, "Mesons Produced by U. of Cal. Cyclotron, May 1948, p. 70.

G-E Develops Mechanical Hands

Ingenious device performs delicate operations in the handling of radioactive materials by remote control. It was developed for handling of radioactive material behind massive radiation shields

THE ACCOMPANYING ILLUSTRATIONS show the operation of an ingenious device which was developed by General Electric's John Payne of the Atomic Power Division, for the handling of radioactive materials by remote control. Known as a remote-controlled manipulator, it constitutes, essentially, a pair of mechanical hands which can perform delicate chemical experiments, operate machine tools, and do countless other tasks requiring great dexterity. In a demonstration, given in New York recently the "hands" also proved that they could perform such common jobs as slicing an orange, twirling spaghetti on a spoon, lighting a cigarette, boring a hole, and writing a name.

In actual use the "hands" would extend over a protective eight-foot-high wall into a radioactive area but would be operated by remote control from a room outside the area, thus insuring against danger to humans from radiation, the scientists said.

Following a visit to the Atomic Energy Commission's Hanford Works, in Washington, operated by General Electric, Mr. Payne said he was impressed with methods used for long distance manipulation of special tools. Shortly after this he happened to see the feats performed with artificial hands by a World War II amputee. It occurred to Mr. Payne that similar devices might be used in an all-purpose manipulator. After more than a year's work, the machine shown was the result.

The actual "hands" are similar to the double hooks used by amputees. They are at the lower ends of two arms which descend vertically from two horizontal shafts eight feet high across the top of the wall. Vertical arms come down from these at the other ends, and carry at the bottoms the handles with which the operator controls the device. He is seated and views his mechanical hands, eight feet away, with the aid of binoculars and a four-mirror periscope which looks over the wall. His feet are on pedals which control the grasping action of the "hands."

The general motion of the hooks corresponds to that given the handles, as they are moved up or down, forwards or backwards, or from side to side. In addition the handles can be turned around three axes, by wrist movement, and this causes the hooks to do likewise. While most of the connections between handles and hooks are mechanical, the twisting of the wrists is accomplished electrically. This permits the artificial hands to

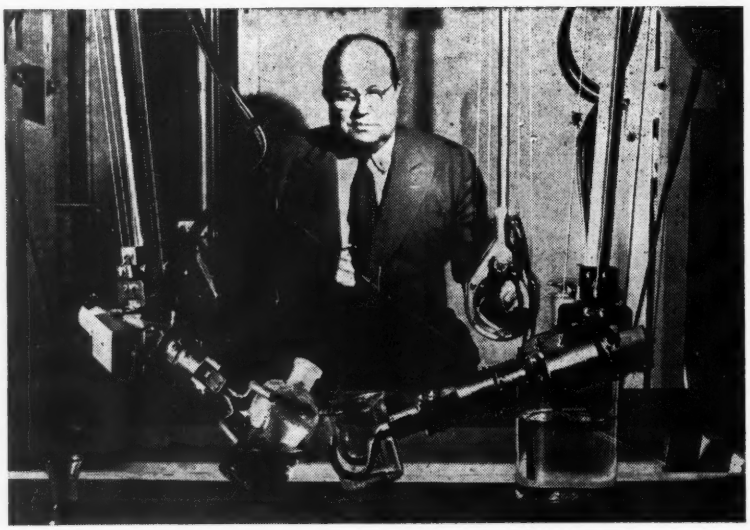


Fig. 1. Here the operator is shown pouring liquid from a bottle into a beaker. Actually, of course, the operator would be stationed behind a protective wall and would observe the operations by means of a system of mirrors

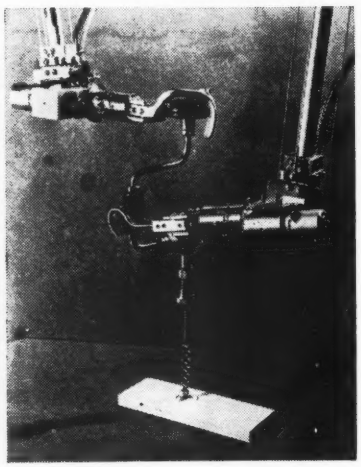


Fig. 2. Drilling holes with a simple brace and bit proved an ABC job for the mechanical hands

do something real ones cannot. They can be twisted around completely, any number of times, which is particularly useful when unscrewing a nut, for example.

It is also possible, from behind the wall, to change "hands." A large one can be used for heavy jobs. If the task requires a more delicate touch, the hand can be lowered into a holder and removed. Then the arm is moved to pick up and attach a smaller hand. Another is provided, instead of hooks, with a pair of snips for cutting sheet metal.

In describing the manipulator, Mr. Payne pointed out that he made every effort to have the motions as natural as possible. Even without practice, it is not difficult to do a simple task, such as removing the stopper from a bottle and pouring its contents into another bottle. With practice much more complicated things can be done, such as writing one's name and operating a drill press. In the latter case, the "hands" pick the proper-sized drill from the box, insert it in the chuck, place the work in position, turn on the switch and feed the drill.

In using pedals to close the "hands" for grasping, Mr. Payne says, he was guided by the fact that most people are accustomed to the feel of a pedal in operating an automobile brake. The pedals themselves are of regular automobile type, and standard auto brake fluid and cylinders are used to transmit their force. It is possible to squeeze an object between the hooks much harder than the ordinary person can do with his fingers. On the other hand, by a more gentle push on the pedal, a very light touch can be exerted, so as to break the shell of a hard-boiled egg without damaging the contents.

Mr. Payne was assisted in the design and construction of the manipulator by Charles Hoffman, also of the General Electric Research Laboratory.

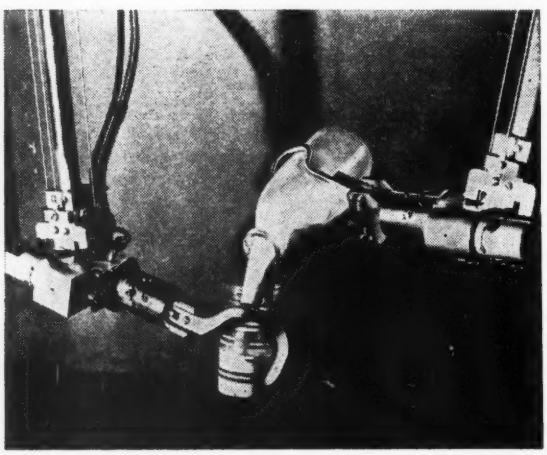


Fig. 3. Just as milk is poured from a bottle into a glass here, the mechanical hands of the remote-control manipulator can mix chemicals in experiments that have to be performed in "no-man's-land" radioactive areas

THICKNESS GAGE FOR HOT STEEL STRIP

CONTINUOUS measurement of the thickness of steel in a hot strip rolling mill at the Irvin Works of Carnegie Illinois Steel Corp. at Pittsburgh, is made by an X-ray thickness gage. In a typical steel mill the strip, at temperature of from 100 to 1750 F, leaves the finishing stand at speeds approximating 2000 ft per min.

As it leaves the rolls it may vibrate vertically through an amplitude of several inches so the clear opening through the gage must be at least 18 in. high. Cooling water sprays deluge the strip and adjacent equipment. The gage, developed by General Electric, operates on the principles of X-ray absorption.

The beam is directed upward from a position below the hot strip as it comes out of the rolls and its intensity is measured by means of a fluorescent screen and a photoelectric cell above the strip. The radiation detector compares the intensity of the beam with a standard reference and shows the deviation on an indicator panel.

By this means it is possible to measure, without contact, the thickness of the hot strips of steel within an accuracy of plus or minus two per cent. Formerly gaging had to be delayed until the strip cooled so it could be measured with a hand-held micrometer. During this period a modern high-speed mill might roll 6 or 8 t of steel. Errors in roll setting is, therefore, very costly because of the large amount of off-gage material produced before the error could be corrected.

While the new gage was designed to fill a specific need, the method is applicable to a large number of industrial problems, and may be used with metals other than steel and with some non-metals.

Savings Possible by Proper Condensate Return Systems

Many industries use process steam to supply heat for drying or curing at temperatures ranging from 200 F to 400 F. In some cases all of the process equipment requires the same temperature, but in many others there is quite a range of temperatures required. For maximum economy the condensate should be returned to the boiler at the highest possible temperature and there should be no loss of flash steam

By **WILLIAM W. GAYLORD,** Consulting Engineer

IF ALL OF THE EQUIPMENT can be operated with steam at the same pressure, the most satisfactory method of returning condensate to boiler is a closed system like the Cochrane-Becker System. In this system the traps are eliminated or by-passed and the condensate removed through an orifice valve in return connection to each piece of equipment by the pressure reduction caused by the action of a jet pump, through which a part of the condensate is constantly recirculated by the motor driven centrifugal pump which returns condensate to boiler.

There are many plants however that have such a range of temperatures and pressures that it is difficult, if not impossible, to apply this or other closed systems. In these cases the returns or trap discharges often go into a common line which discharges into a vented receiver from which condensate is pumped back to boilers. As all returns are thus reduced to atmospheric pressure there is a considerable loss of both heat and condensate by the escape of flash steam. Unfortunately there is no simple way to avoid this loss where a large part, 65 per cent or more, of the condensate can be returned to the boiler so that little make-up is required.

The Stepped Pressure System

Where considerable process steam is used at near boiler pressure, considerable more at an intermediate pressure, and some steam for process and heating is used at low pressure, a stepped system should be used. In this system the traps from the high pressure equipment would discharge into a high pressure return line connected to a high pressure ecreiver. The traps from the intermediate pressure equipment would discharge into a seperate return line connected to an intermediate pressure receiver. Finally the equipment traps would connect to a return main discharging into a vented pressure receiver.

Such a system is shown in the diagram in Fig. 1 where there is one group of process equipment operating at pressures between 100 and 150 psig, a second operating at pressures between 50 and 100 psig and a third group of process and heating equipment operating at pressures between 5 and 10 psig.

This shows a plant consisting of two boilers each of which is equipped with a feed water regulating valve controlled by the water level in the boiler while the pump which returns water to the boilers from the high pressure receiver is arranged to run all of the time.

This pump would be designed to handle the full capacity of the plant at a pressure differential of 80 lb, but to have its capacity reduced to about one half this when the pressure differential goes up to 170 lb. A relief valve set at 180 psig should be installed in feed line to boilers to recirculate feedwater to receiver in case both feedwater regulators should be completely closed at same time. All high pressure condensate is returned direct to this high pressure receiver.

If there is only one boiler in the system the boiler feedwater regulator could be arranged to control the pump so that it would operate only when required. With two boilers the same arrangement could be used by using two pumps, each connected to receiver No. 3. Air and other non-condensate gases are vented from this receiver by an automatic air valve and a pressure relief valve, set at 93 psig, which vents flash steam to the intermediate return line should the temperature of the condensate in this receiver rise above that corresponding to this pressure.

The returns from the intermediate pressure process equipment discharge directly into the intermediate pressure receiver and are pumped into the high pressure return line to mix with high pressure returns as they enter high pressure receiver by a pump the operation of which is controlled by the water level in the high pressure receiver. Air and other non-condensable gases are vented from receiver No. 2 by an automatic air valve and a pressure relief valve, set at 42 psig which vents flash steam to low pressure condensate line when required.

The returns from the low pressure process and heating equipment discharge into a low pressure receiver which is vented to atmosphere through a vent condenser and back pressure valve set to open at 3 psig. All make-

(Continued on page 135)

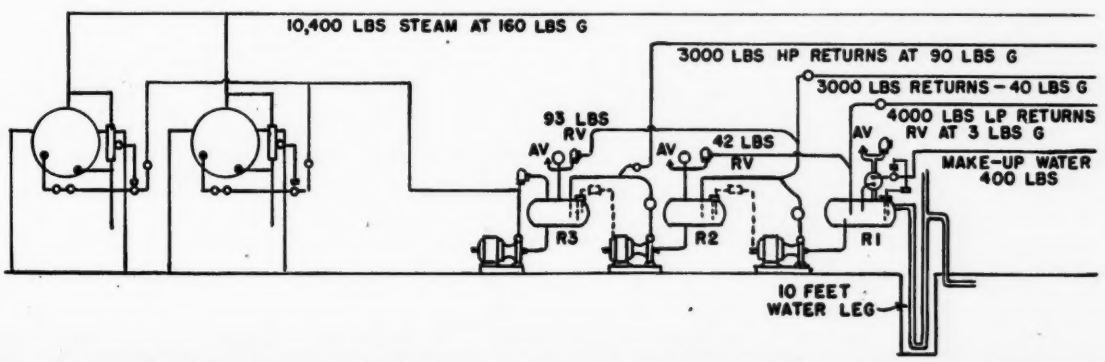


Fig. 1. Diagram of a stepped pressure condensate return system. This plant, consisting of two boilers, has one group of process equipment operating at pressures between 100 and 150 psig, a second between 50 and 100 psig, and a third group between 50 and 10 psig

The PRACTICAL ENGINEER

DEVOTED TO PLANT OPERATION and MAINTENANCE

A. W. KRAMER, EDITOR

What Makes an Engineer?

Changed conditions in power field make new demands on engineer . . . Background requirements . . . Opportunities available . . . Mental equipment necessary . . . importance of language . . . Value of College education . . . Books and the need for a personal library . . . Relation of the engineer to labor organizations.

By DONALD FREDERICK

OUR TECHNICAL MAGAZINES, such as POWER GENERATION, from time to time devote considerable space to the subject of engineering training and the development of engineers for the operation of our many thousands of power plants. Still more attention should be given to the subject. New types of power plants are coming into use. Complex devices for the generation of steam and electricity require highly trained men. Tomorrow it may be atomic or nuclear power that engineers will contend with, and the day after tomorrow it may be something else.

This is not addressed to our older men who have toiled long and well in the boiler plants and engine rooms. They have not necessarily "had their day" but many of them have a viewpoint that will not be changed by this article.

What this writer has to say is directed to men who want to become engineers in the strict sense of the word. The discussion is intended for men who, if they want to succeed, must view the job of operating a plant in all its broad aspects.

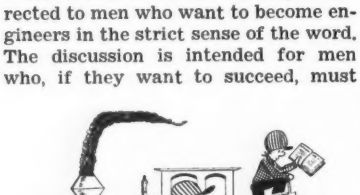


Fig. 1. "I decided that maybe a correspondence course would unravel some of the mysteries about locomotives"

After just about two-score years of experience in the field this writer has come to some conclusions. I have, to my own satisfaction exploded a few myths about "engineers" and their profession or trade, or whatever you may choose to call it.

Back when I was about 16, I fired a locomotive and did a pretty rotten job of it. So I decided that maybe a correspondence course would unravel some of the mysteries (they seemed to be then) about locomotives. Some of the mysteries were cleared up but I learned a lot of other things. One of the important things that I learned that in later years has been confirmed is that a basic education of a secondary school grade is an essential. The correspondence course taught me a little about locomotives and a whole lot with regards to my needs in the way of sound, formal education of an academic nature.

After years of kicking around from coast to coast, during which time this need for a basic education became more and more pronounced I decided to do something about it—and did.

During high school years I worked eight hours a day in an up-to-date power plant and during that period became a "watch engineer" and worked with men who were "licensed engineers", who thought that because they held a license they were, ipso facto, engineers. Which brings me to a point.

My experience with my fellow "engineers" was worth its weight in gold —and still is—but I learned very little real engineering. I set valves, cut engines in and out, put turbines on the line, took care of emergencies and not once (in several years) did I blow the place up. But I didn't earn my money. The "four-to-twelve" watch did nothing from eight o'clock on and the "twelve-to-eight" watch slept until six a.m. when they put the plant in operation for the day.

The Chief did the buying. Slick salesmen sold him anything that looked good to him. He could no more specify a lubricating oil than the man in the moon. Nor could he do a lot of other things that he should have been doing for the management. But he though he was an engineer. When we put in air conditioning he couldn't understand the difference between freon and ammonia — and what is worse he never tried to learn.

An engineer must have or must develop a curiosity about his trade or profession. It is not enough to hold an operating license that says you can run a "high pressure" boiler plant; it is not enough to be able to pack a pump or put a condensing turbine unit on the line, or all the other things that stationary engineers are in the habit of doing.

Certainly as a background for engineering work a man must have a good secondary education. If he has, he will be curious. If he is in a large city (or even some of the small ones) there are colleges, good trade schools, or vocational schools.

With the proper background in the way of a formal secondary education a man can do a lot of things. He can supplement this with a correspondence course which will benefit him greatly. He can learn something about chemistry, at least enough to understand fundamental chemical reactions common to feedwater. He can gain confidence in himself so that he can serve his management properly and be of real value to the organization. Futhermore such a man has influence on those around him in that the standards in the plant rise.

My discouragement with "stationary engineers" drove me on to take a degree in mechanical engineering and later to work for a master degree and then to licensed professional engineer. I soon learned to turn a deaf ear to those who whined about lack of opportunity.

No country in the world offers more opportunity with regard to education than this one. There is no excuse whatever for a man to be without education in his profession.

My experience has taught me that an engineer should associate with engineers through a society or organization that promotes exchange of ideas and where men can raise questions and the proper answers. Experience gaine from membership in the ASME

Fig. 2. "Slick salesmen sold the Chief anything that looked good to him"

and running a local section could never have been obtained by this writer.

A man can hardly pretend to be an engineer or pretend that he wants to become one unless he keeps abreast of current developments in his field. This means that he should begin early in his career to acquire a technical library of his own. By library we do not mean an expensive assortment of books that are purchased for show. Not more than a dozen or so of good books will provide ready reference for questions that come up in every day work. The young, developing engineer ought to follow the technical magazines closely. In the technical press may be found the down-to-earth experience of seasoned men; these experiences should be acquired by the engineer through his reading.

What mental equipment should the young engineer bring with him to the profession? As has already been stated at least a basic education equivalent to secondary school is a prerequisite. But this requirement does not define just what the engineer should have in his head in the way of "tools". Well, he ought to be able to make simple calculations involving the determination of unknowns in ordinary algebrai equations; elementary plane geometry thrown in will help him. In his secondary school work he will get elementary chemistry and physics along with lab work. On his own he can get a good knowledge of the theory of combustion. A man who aspires to become the chief engineer of a modern plant certainly should be able to run an approximate heat balance on his plant to find out what he is getting for his fuel money. This means that he must understand the factors involved and be capable of analyzing them. Nothing in these requirements assumes a knowledge of college chemistry, physics or thermodynamics.

Where all engineers fail miserably is in the field of language. The one thing we must understand in order to study, interpret and communicate is language; and by language we do not mean a foreign one.

Unless an engineer understands the fundamental language he is not equipped to learn nor to advance in his profession. Why is it necessary (or is it asking too much) for an engineer who operates a power plant to understand English? It is necessary because he must communicate in this language, both spoken and written, and because he needs this very important tool in order to learn for himself and to improve his grasp on his business.

Most operating engineers do not serve management, as well as they should. Perhaps this is because the engineer in the power plant has traditionally felt that his job is to keep things running. This is a fallacy; it never was true. In addition to keeping things running there is a question of economics. Plants must be run efficiently; the operating engineer should know how to obtain his costs and how to use them. He should, further, be in position to present them to his management in an intelligent manner. Day by day engineers are moaning because their plants are being scrapped and being replaced with utility power, but we have yet to hear an operating engineer attribute the loss of his job to his own sins of ommission. It is in such instances that the operating engineer clearly emphasizes the difference between engineering as a trade and engineering as a profession.

Critics will immediately seize on this as being an argument for making a college degree mandatory. This is only a defense mechanism at best. A college degree does not make a man an engineer nor will it cover up incompetency. Thousands of our eminent engineers never saw the inside of a college classroom; they did have the drive and natural curiosity that makes a man learn, absorb and utilize. College, after all is simply a place where knowledge is classified, organized, and arranged so that it can be imparted to those who are exposed to it with a minimum of effort on the part of all concerned. The most important thing for the young engineer to keep in mind is that the "book learning" 'of colleges is available to him if he wants it. He will have to put forth effort, but if he is the type who will do this his effort will be well rewarded because of the self-discipline he must impose and because of the personal efficiency he will develop.

Unless a man understands that one of the marks of the professional is his willingness to contribute to his profession and society in general he is failing in his career. As we grow in our profession we grow in our understanding of the world about us and the needs of society in which we live. This means that we ought to get ourselves in position where we take on professional and civic responsibilities. There are great opportunities for service to the engineering profession and to the community. This service has nothing to do with politics; it has to do with improving the standards of the profession, the individual engineer, and the institutions that go to make up a progressive community.

The young engineer can do a lot for himself and his profession if he will take a little time to read a few good books on the history of the engineering profession and the men who have made it a science. Such a reader will be amazed to learn that the geniuses have been few and far between, and that the greatest men have acquired academic honors after achievement and not before.

Such books should be a part of the young engineer's personal library if he does not have access to them otherwise. There are lists of such books (free, practically for the asking) available from the recognized

Fig. 3. "Young engineers ought to follow the technical magazines closely"

engineering societies and they embody a wealth of knowledge and inspiration that cannot be had elsewhere.

In this age of specialization, where "engineers" are made in 90 days the young man must be on his guard against the "smattering of ignorance" school of thought that tends to make robots of men. When such specialization is carried to its ultimate the machine will control the man outright, and to fit in with such a scheme of things the man will have to be controlled politically and socially. It is not the role of the engineer to be controlled; he is the harnesser of nature's beneficial forces and it is he who works with the laws of nature to forge his own destiny and to assist

in the raising of standards for his fellow-men.

Someone will say, undoubtedly, that the operating engineer certainly can have little to say about "destiny" and "welfare" and other abstractions. The answer to this is that as long as he is willing to remain an "operating engineer" he obviously will have little to do about such things. In such circumstances he will be in the group whose destiny is being controlled when he ought to be doing something about the controlling.

We probably leave out an important point in this discussion if we did not say something about the engineer's relation to industry. We are convinced that one of the present drawbacks to engineers' advancement is their willingness to align themselves with "labor"; the word labor is put in quotes to differentiate it from honest toil. It is traditional in any profession worthy of the name that rewards come from achievement and contribution. In the field of modern unionism this fundamental between the journeyman and the engineer is not recognized. The engineer who takes position with those who obtain returns from industry by pressure and force is contributing to the depression of conditions that enhance his own welfare. In all groups there are those who move about in a marginal fringe due to a variety of reasons. Their feeling of insecurity makes them prey to those who gain by mass pressure. When engineers are drawn into these pressure groups they forfeit certain rights that the individual should have. Labor unions are an accepted necessity in our industrial economy, and it is difficult to conceive of a high standard of living for the workers without collective bargaining.

But modern industrial unions must extract from their members a simple faith, and the membership must be lumped in a simple category—the good with the bad—for flexibility. To be effective the unions must stick to their basic objectives — security through higher wages, controlled output, and mass action while the economic responsibilities must be shouldered by others.

An engineer cannot advance under such restrictions. What makes an engineer is his acceptance of his individual place in the profession, the business world, and society. Only his individual freedom permits him to perform "beyond the call of duty" where the returns are in direct proportion to service rendered. No man can be an engineer in the absolute sense because the science is an advancing one and the absolute goal is never reached. While the engineer may serve his profession in a power plant, or on a designing board the obligations are the same; there is an ideal, akin to the American Dream, that we must seek.

Turning Commutators in Place

It is not always a simple task to remove the armature of a motor or generator, especially if it is a large one, and mount it in a lathe for resurfacing. The author describes a simple rig which may be attached to the frame of the machine to hold the cutting tool and allow it to move across the commutator. The rig can be built in any plant shop.

By EARL PAGETT

COMMUTATORS on direct motors or generators eventually wear away to the point where they must be resurfaced. The wear may be evenly distributed, and again it may not, but whichever is the case, the main object will be to get it turned smooth and true.

It is not a difficult job if the armature and shaft can be conveniently removed from the machine and taken to a lathe. If this can not be done practically, it becomes necessary to turn the commutator in place. This means that some sort of device must be designed that may be attached rigidly to the frame of the machine to hold the cutting tool and allow it to be moved across the commutator in such a way that the depth of the cut may be adjusted as desired. This may involve more work and complication than is at first evident.

In the first place it is no small job to design and then build a rig to hold the tool securely enough so that it will not chatter or "hog" or do something else undesirable. When it is completed, it is still quite some task to find a way to fasten it on to the machine and line and level it accurately with the commutator. Also, some way must be found to rotate the commutator at something near the proper cutting speed.

The writer does not wish to pose as an expert, but has had to do quite a few commutators in place and a description of the work and of some of the things encountered may be of interest.

The rig that was used in most of these cases was a home shop made affair, shown in Fig. 1, 2 and 3.

It consists primarily of a feed screw about 1 in. diameter 20 threads per inch, a nut to fit on the screw, two end pieces, bored to a press fit for the ball bearings on the screw, two side pieces about ⅜ in. thick and 3 in. wide, a top plate, slotted for the extension on the feed-nut to travel in and dovetailed to fit the longitudinal feed block, which was attached to the feed-nut as shown. This block was bored to receive the cross feed and the tool post, which were borrowed from a small lathe in the shop.

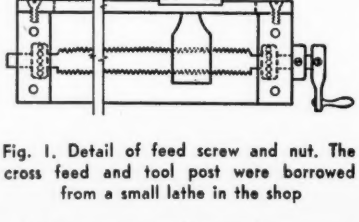


Fig. 1. Detail of feed screw and nut. The cross feed and tool post were borrowed from a small lathe in the shop

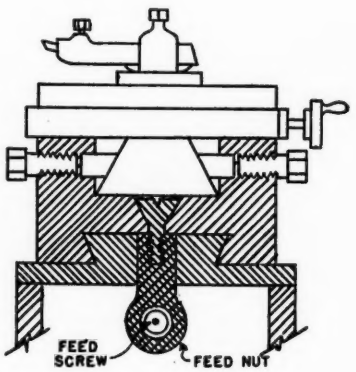


Fig. 2. Cross section showing method used to attach the cross feed and feed nut to the longitudinal carriage

The dimensions had to be made for what might be foreseen to be the largest job likely to be encountered and the rig adapted to smaller jobs as they come up.

Thus the screw had to be made long enough so that there would be sufficient travel to feed the full length of the largest commutator without having to reset the whole rig. This is important, as it is very difficult to run the cut part way, and pick it up again without it being apparent, where one cut stopped and the next one started.

Accurate work is required, in building this rig, as there can be very little clearance in the moving parts, still they must move freely.

When the rig is completed, ways and means to apply it to the job must be devised. In this case it was decided to use the two cap screws holding the bearing pedestal to the bed plate, for fastening the rig to the machine.

As this machine was quite large, it was some distance from the bottom of the heads of these screws up to

the center of the commutator, at which level the point of the cutting tool should be set.

The rig as described was not nearly high enough to bolt directly, so a piece of angle iron was drilled with two holes for a loose fit over the cap screws, to bolt on as shown at "A" in Fig. 3.

A piece of flat plate ⅜ in. thick was then cut the length of the rig and of such height that the tool would be at the right level, when the plate was bolted to the angle, and the rig bolted to the plate as also shown in Fig. 4 at "B".

While the method of fastening was fairly rigid, an extra brace was fastened to one of the bolts holding the rig to the plate, and clamped to the frame of the machine. A small screw jack, or equivalent, was set between the free end of the angle and the floor

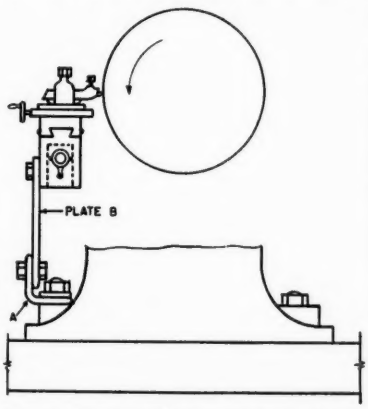


Fig. 3. Rig was bolted to a piece of flat plate and attached to the frame of machine as shown above to bring the cutting tool to the proper height

or frame of the machine, to minimize vibration.

To adapt the rig to smaller machines, new holes had to be drilled lower down in the plate and the feed mechanism lowered down to the required level, in fact, some machines were encountered in which the mechanism was bolted directly on to the angle.

One brush holder, at least, must be removed from the yoke, and all other brushes raised and the field circuit kept open. The end play of the armature and shaft should be blocked, so that there will be no chance that the commutator can oscillate either away from the cutting edge of the tool, or towards it. When the device is assembled and secured to the machine, it must be checked for level and alignment.

In case that the wear has been uneven, the armature shaft may also be used to level, and in aligning, a point at the outer end, outside of brush contact, and another at the back end of the commutator, beyond brush contact, should be used.

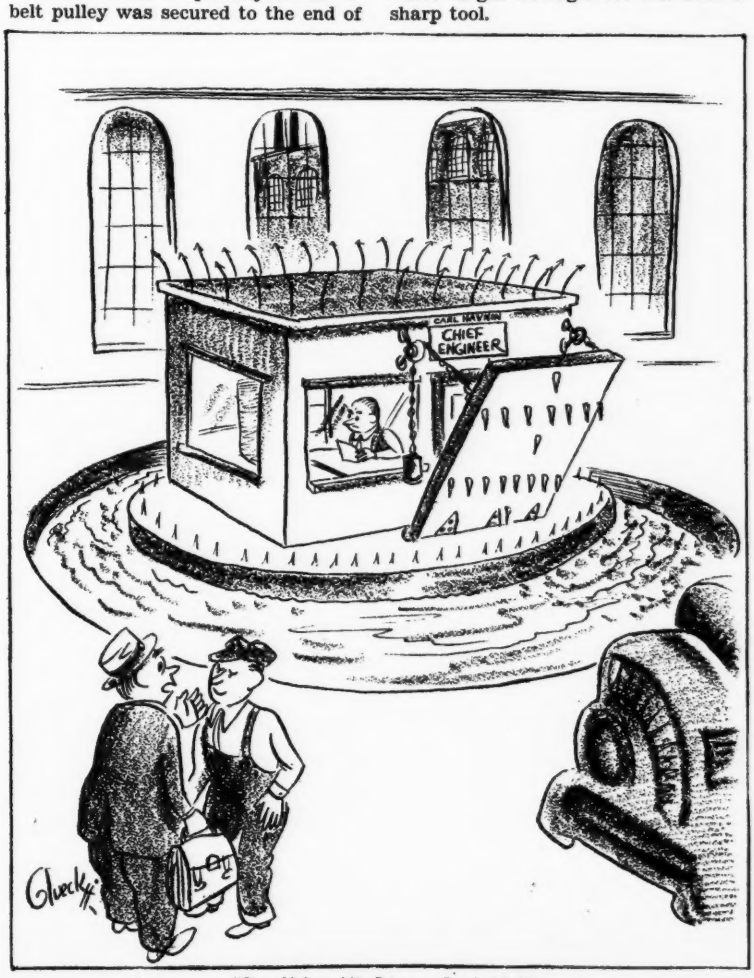
In aligning, the cutting tool is brought up to almost touch either of these points and a measurement taken between the point of the tool and the commutator with a feeler gage, after which the tool may be 'cranked' to the other point and a corresponding measurement made.

If the two measurements are not the same, shims equal to the difference between the two measurements, may be inserted between the plate and the mechanism at the nd of the greater of the two measurements and the measurements compared again, and if not equal the procedure must be repeated until they check equal.

If the machine is a generator, the engine or other prime mover may be used for motive power, provided it can be slowed down sufficiently. If it is a motor, the belt may be removed and a small motor belted to the motor. The speed may the be governed by pulley ratios.

In one case, a specially made V-belt pulley was secured to the end of the armature shaft. The commutator was revolved with an air motor, equipped with a corresponding pulley, and the air motor secured in a frame which was fastened to the floor. A motor generator, having two commutators, was driven by a small backgeared motor with a fiat belt pulley and belted around the commutator not being turned. If the commutator speed is not too great, this type of machine may also be run by the driving synchronous motor. However, all brushes must be lifted on the direct current end, and the generator field left open.

The cutting tool used was the usual diamond point, slightly flattened on the point. It should be kept very narrow, as too wide a point will cause 'chattering.' One difficulty encountered was that the tool would lose its edge, before the cut was finished across the full length of the commutator. The writer was at a loss to understand why this should occur as copper should not wear tool steel away so quickly. It was decided that there was an abrasive effect from the mica and carbon dust, which made it difficult to get through the cut with a sharp tool.



"Sure Values His Privacy, Don't He?"

So—You are Going to Take an Examination!

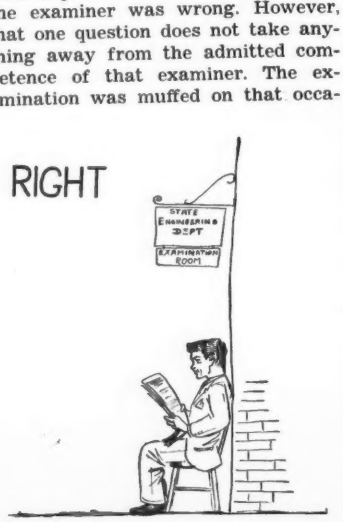
Part III—The Examination. The importance of being mentally relaxed before taking an examination . . . confidence in your ability . . . The "trick" question . . . Don't bluff or guess . . . Closing the door on yourself . . . Stick to the point . . . Planning for the future.

By CYRIL F. GREENE
Resident Engineer, Traveler's Insurance Company

THIS IS THE DAY that you have been working towards since you first started to prepare for the examination, and regardless of the outcome, it holds very definite advantages for you. If this is to be your first examination, then promise yourself sincerely that it is the first step in the way of advancement in the kind of work that you want to do, and that you will follow up this step to your own advantage.

The greatest benefit for you lies in the fact that you will spend a certain amount of time in the company of one or more men who are well informed and widely experienced in the kind of business that you are most interested in as far as your own future is concerned. It is well to remember at this point that no examiner is perfect in his knowledge, and that he too can be mistaken in regard to the facts. The author recalls an examination where he did not seem to provide the required answer to a certain question. Later, after much searching, he found the answer that was expected of him and felt extremely stupid because it did not occur to him at the right time.

In the twenty odd years that have passed since then, the author has seen it proved that he was right and the examiner was wrong. However, that one question does not take anything away from the admitted competence of that examiner. The examination was muffed on that occasion because the preparation had been incomplete and not because of his handling of that particular question.



Confidence in Your Ability

It is well to remember that the examiner will base his questions on what, in his opinion, you should know at the time of this examination. This fact is most important to you. If your study has been well planned and you have attended to your work as well as you know how, then you cannot help but come up with a good batting average. It may not be quite good enough to win for you this time, but the examination cannot help but show you where more time and effort should be spent. When you take your car to a repairman for a checkup you do not do so because the car is ready to completely fall apart, but because you want him to find out what needs to be done to restore efficient operation. It is usually one or two adjustments that have to be made and the same point applies if you do not pass the examination. There are a couple of points that need to be strengthened before you can qualify.

Relax Before the Examination

Do not let the location of the room where the examination is to be held scare you. Perhaps the only time you have ever been in the State House before this examination was the time that you and the rest of the eighth graders came down on an excursion. The point to remember is that as a taxpayer, the State House is partly your property, so there is no need of being nervous in a building that you have a share in.

If there is any chance that you will have to wait around for your turn, then take along something to read while you are waiting; don't take anything connected with the examination. This will serve to take up the time and it will also help to keep you from getting into a discussion with other chaps in regard to the examination. Discussions at this point cannot help anyone.

When the time comes for you to enter the examination room take about twice as much time to get in there as you think you need and that will be just about the right speed. If no one tells you pleasantly where to put your coat and hat, then it is just an oversight on someone's part and you find a place for them. It is beyond question that you will be invited to sit down sooner or later, so you might as well wait for the invitation. Then you will be given the proper seat.

If the room contains pieces of equipment that will be used in the examination try to refrain from gaping around wildly to find out just what check valves are on the line backwards or just what wires have been crossed up just for your special benefit. You will not gain anything by doing this and you will indicate to the examiner that you are nervous. If you must look around, spend your time figuring out a way of escape if the place catches fire and you could not use the door that you entered by. That will keep your mind occupied.

It is well to be reasonably courteous to the examiner and he will, no doubt, act that way towards you. It is very unwise, however, to overdo this courtesy business and be too humble and ingratiating. Such an attitude will not charm the examiner with your personal qualities.

Avoid getting discouraged if you get away to a rather rocky start. Remember that the examiner has met many men in just the spot that you occupy right now. He is fully aware that it sometimes takes a few questions to settle the candidate down so that he can become at ease. A good example of this occurred when the author was taking one of his early examinations. The examination was supposed to include a working knowledge of the simplest forms of steam engines and nothing more along that line. He was completely overwhelmed when the examiner, whom he had never met before, asked him for a brief description of the operating principle and general characteristics of the unaflow type of steam engine.

Deciding to play it safely, he told the examiner that he knew very little about unaflow engines. He added that he felt that he should study the necessary things for this examination and take on more complex matters at the proper time. The examiner's attitude was kindly and his words were very much to the point. He said that the unaflow type of engine was a good design and that it would be around for many years to come. Also that he would advise any younger operating engineer to learn about it at an early date. He then proceeded to pose an even dozen carefully chosen, practical questions that wound up a good examination in my favor.

Now as to the "catch" or "trick" question! I can state with perfect

truthfulness that no examiner has ever showed the slighest interest as to what my reaction would be "if I were operating a boiler at 100 psi and one of the man-hole plates suddenly fell into the boiler." Neither have they taken the time or trouble to inquire whether I knew how long the handle is on a water hammer, or how to reverse a feed pump in case the water level in the boiler gets too high.

That reminds the author of a radio quiz show that I was listening to recently, where a charming and well informed young lady was well on her way to hit the jackpot a resounding wallop. Then came the question, "How many musical notes in two octaves?" Almost before the quiz master had finished the question, she shot back "sixteen!" and there went her prize money!

You might say that was a "trick" question, but I would not agree. Where she tripped herself up was in her eagerness to show off her knowledge. It would have only taken her a second or so to have visualized a piano keyboard and then the situation and the prize money would have been saved. So don't be an eager beaver and rush to show off if you get a question that you are sure that you can handle right away. Remember that the questions are designed to find out how well you think as well as how much information you have acquired. From the first to the most important examination it is serious business with the examiner, and you will generally find that the questions make good sense. Then, too, if you hurry you simply make time for more questions during the period of time that has been allotted to you. Why knock yourself out answering twenty questions when, by being careful and deliberate, you can qualify with fifteen. On the other hand, don't attempt to stall! Just give each question careful thought before attempting to answer it.

Don't Guess or Bluff

Regardless of how long you may have been reading POWER GENERATION, did you ever read an article that was admittedly based on guesswork? Of all the interesting subjects that have been discussed, there have always been the supporting facts. There is good lesson to be learned from this which will help you with your examination. Don't guess! There is nothing unusual in running into a question to which you do not know the answer. What you should not do under such circumstances is to get confused and then try to pick an answer out of thin air. Of course there might be one chance in ten that you would guess the right answer, but if you miss, then it is nine chances out of ten that you have tagged yourself as a poor guesser and a man who might try to do some guessing when he is in charge of a plant instead of going to the proper place for the correct information.

Don't Close the Door on Yourself

Much more to your advantage is a simple statement of fact and there is no reason why such a statement could not be helpful to your cause. If you honestly feel that you do know this particular subject quite well, but that you have missed this particular point, then it would be wiser to say that you had spent a great deal of time on that subject, but the point of the question was not clear to you; rather than to make a definite statement that you do not know the answer. Explaining your position briefly, instead of trying to bluff or guess leaves the question open for a different approach by the examiner. However, if you simply say that you do not know the answer, then you are closing the door on yourself.

Do not argue! The only thing that you can prove by arguing is that you are argumentative. Arguments are helpful and constructive when they take place among the men at the plant on subjects of engineering interest. In the examination room, however, they are harmful and out of place.

Stick to the point! Answer the question as carefully as you can but be sure not to go beyond the limit of the question. If you go beyond the point of the question and talk of matters that are not too closely related to it then you may be leading yourself into trouble.

When it is all over and you have either passed or you have not, there is still work to do.

Win or Lose—Plan for the Future

If you have passed your very first examination then it is time to plan for the future. If you have passed the final examination and your qualifications and authority are unlimited there are things for you to remember too. Most important, is that you remember the helping hands along the way that you have traveled and a resolution on your part that you will give a lift to any man who is studying to improve himself.

PRACTICAL ENGINEER SECTION

Win or lose, go back to your information files and record such facts about the examination as will be helpful to you. Don't try to record the exact questions since the chance that they will be repeated in the same form is not giving the examiner credit for having very much imagination. Rather, record the subjects that were covered, indicate just what points were brought out in each case and record any points of discussion.

Never overlook making a record of anything that the examiner might have told you that is of a helpful nature. Examiners are just as prone to say helpful things as anyone else, so if they do throw in some words of personal advice or technical information, then make every effort to retain it.

Finally, don't get mad if you fail. Blaming the examiner or the law that he is working under is a foolish waste of time since there is nothing that you can do about either one.

Equally unwise is any tendency to criticize yourself for the failure. This business of engineering in any of its many branches requires the continuous expression of confidence on the part of the men that work in it. The man who finds fault with himself because he has failed in an examination is not doing anything to build up his confidence. In fact the opposite is true! Better luck next time!

DIESEL LUBRICATION

(Correction)

IN THE ARTICLE on Diesel Lubrication on page 70 of the February issue of POWER GENERATION, the photograph of the centrifuge and filter shown in Fig. 3 should have been credited to The DeLaval Separator Company.

All the other photographs in the article were credited to the manufacturers from which they were obtained and there was no intention to discriminate.

* * *

AN EFFICIENCY expert is one who knows less about your business than you do and gets paid more for telling you how to run it than you could possibly make out of it even if you ran it exactly right instead of the way he told you.

* * *

THE MANAGER was interviewing an applicant for a technician's job. "For this position," he said, "we want a responsible man."

"That's me, boss," the applicant answered. "The last place I worked, every time anything went wrong, they told me I was responsible!"

LETTERS AND COMMENTS

PROVISIONS FOR SURFACE EXPANSION MAY REDUCE SPALLING

By Jay See

THE MANUFACTURERS of refractories have given us an article of high heat resistance, but what have they done to reduce the spalling which has pestered us in the operation of boiler furnaces?

An experience in providing for expansion led our crew to experiment in the use of a plastic lining for the side door of a chain grate stoker. These boilers, operating on a heating load, will reach 200 per cent of rating at times and the whole interior of the furnace becomes incandescent.

Side door linings of a good plastic were renewed every year because of the heavy spalling. We then tried a piece of corrugated paper fitted into each corner, full depth. The door was about 18 in. wide, 15 in. high and 4 in. deep. In the center is a peep hole about 4 in. square on the fire side.

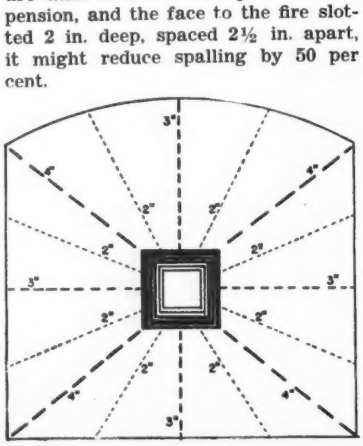
The corrugated paper helped, so the next year we inserted more paper half way between those in the four corners, only 3 in. deep. Now we have 16 slots in a plastic lining, one of which has been in service for 5 years and the other, 6 years. There is no sign of spalling.

The idea of the slotting was to provide for surface expansion; it being our belief that the surface to the fire was much hotter than it was 2 or 3 in. in from this.

The surface wants to expand at a greater rate than the material in back of it. This straining eventually causes a fracture which results in spalling.

Are we right? We think that we are. Also we have a thought on suspended arch tile.

If this class of refractory could be made smaller at the end facing the fire than it is near the point of suspension, and the face to the fire slotted 2 in. deep, spaced 2½ in. apart, it might reduce spalling by 50 per cent.



Looking from inside furnace through side door opening, showing slots in plastic lining

The resistance of refractory material to heat penetration and the depth of penetration would appear to be factors worthy of the manufacturer's interest.

THE "OLD GIRL" PUT UP QUITE A BATTLE!

I'D LIKE TO tell a little story about a test which has been going on in our plant for almost a year now. Electricity is very cheap here, and since the price of coal has gone up so much, the company officials thought power could be bought cheaper than it could be made. The only drawback was that we heated water for process work with the exhaust from the engine.

They called in a couple of "experts" to make a survey. The company really wanted to take the engine out as they figured it was getting old and might go out itself some day. Well, these "experts" fooled around practically all of last summer and most of this winter. I couldn't help thinking to myself what a battle the "old girl" was giving them, as they found out eventually it took as much live steam to heat the water as the engine required, and they still had to pay for power!

It sort of tickled me that in spite of the high price of coal and the low cost of power, about 9 mills per kwhr, we were still better off with the engine than without it as the "experts" claimed. At any rate, the "old girl" is still running. Now we are talking about installing a turbine. This is, of course, what should be put in. We use a lot of steam for process work and with an extraction type turbine, we could have our power practically free.

GREENHOUSES ARE THE SECOND LARGEST USERS OF COAL

HEATING IS THE largest single item of expense, next to labor, in growing flowers indoors, according to the *Florists' Review*, florists and greenhouse trade journal. Greenhouses, among all industries, are the second largest users of coal. The florists' profits are entirely dependent on (1) low heating costs and (2) efficiency of the heating system. Worn-out boiler units and sluggish heating lines constitute problems that all florists must solve at once. An exact balance of heat, moisture and air must be maintained in the production of flowers under glass.

According to the *Florists' Review* there are more than 200,000,000 sq ft under glass in commercial greenhouses and more than 15,000 florists growing flowers for wholesale and retail distribution. Sizes of individual greenhouses range from 5,000 sq ft to more than 1,000,000 sq ft under glass. The market for heating equipment is not only large, but also embraces all types of equipment.

COMMENT ON REFRIGERATION OPERATION

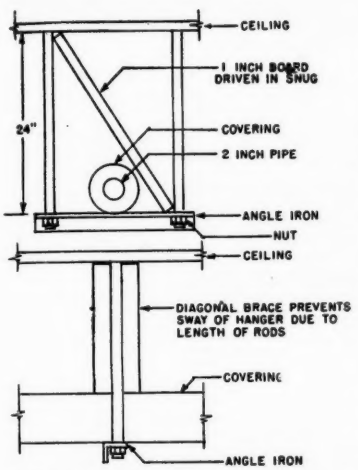
OUR VILTER 5½ by 5½ duplex 1926 ammonia compressor has caused considerable trouble burning up piston rings. We finally eliminated the trouble by leaving on or putting back used rings on the piston below the suction pass. These rings were always found in good condition while those above the suction pass would sometimes wear entirely in two. It was reasoned that the lower rings held back too much of the oil either from blow-by or scraping it back, and the pistons were drilled and beveled already for the purpose of draining the oil back.

We were not equipped to properly bevel one side of the rings, and there was no evidence of any blow back past the lower rings, so we decided to try leaving the old rings in and grinding a flat on the underside of each pin where it fits into the piston bosses. This was not harmful in any way, since the retaining setscrews sit against this flat. The flat allowed some oil to pass along the pin to the cylinder walls from the connecting rod pin end, which is oiled by the ball check splash cups which dip into the crank case oil.

We also had trouble with the relief valve on this same compressor. It sets in the valve assembly manifold, and in case of excessive discharge pressure, allows the gas to pass from the discharge to the suction line. We had sort of forgotten that there was a relief valve there, the machine was running hot and did not properly handle the gas. We were led to suspect that we had the old ring trouble again until we found out different. We discovered that the machine would not build up any pressure greater than the condensing pressure with the discharge valve entirely closed, and that the suction line near the machine was almost as hot as the discharge line; the cylinder walls and crank case, were also heating.

The valve itself has a blunt needle-point, about ¾ in. in diameter at the large end, and held to its seat by a strong coil spring. The seat is a lead cylinder, ¾ in. OD, ⅜ in. ID and ½ in. long. It in turn sets in a seat in the manifold casting about ⅛ in. deep. It had in some way jumped up and tilted with one side resting on the top edge of the seat and was badly mutilated. Molding or turning a new seal ring from lead was not considered very easily done. Therefore, we decided on a steel one.

We screwed a ½ in. full finish hex nut tightly on a stud, polished the outer end, and turned the entire face



of the nut with a heavy coating of solder. This was to serve as a gasket between the ring and its seat in the manifold casting.

The stud was chucked in a lathe, and both sides of the nut faced, leaving a sufficient coat of smooth solder for the under side, and turning the nut down to ¾ in. diameter and bored a ⅜ in. hole back into the stud farther than the thickness of the nut. The edge of this hole was slightly beveled and left chucked up; the needle point was chucked in a universal toolstock chuck, pushed up against the ring after applying fine grinding compound. The headstock chuck was oscillated by hand until a good seat was obtained, cutting stud flush with nut completed the job.

I would like to mention that our suction line is suspended on hangers which comprise 2 rods hanging down from the ceiling threaded at the lower end and a piece of channel iron across to support the pipe. These would have a tendency to sway back and forth with the pulsations in the suction line, and were corrected as shown in the accompanying sketch.

Great Bend, Kan. C. L SHOBE.

Questions and Answers

Question No. 415

HOW CALCULATE THIS GAS TURBINE FOR AIR COOLING?

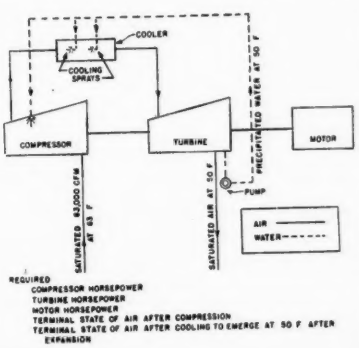
IN A CERTAIN process we have the problem of taking 83,000 cfm of saturated air at 63 F, and reducing its temperature to 50 F, still maintaining saturated air.

As one approach to this problem, we noted the discussion of the use of a gas turbine refrigeration cycle given by John I. Yellott in the Gas Turbine Power Plant—VIII, POWER GENERATION, February 1948, page 97, Fig. 8. However, this is not exactly the same condition that we have, for while the air is at moderate temperature it is not as high pressure as discussed by Mr. Yellott.

We are wondering, therefore, if the arrangement shown in the attached sketch could be used? One objective would be to avoid introducing additional water into the circuit at some expense.

It would be possible to produce the required reduction in the saturated air in this case by using air conditioning equipment at considerable expense. However, it seems to us that this could be done by the method shown, which would generate some power in the gas turbine, or more properly air turbine, without the addition of any fuel energy in a combustor and with some recovery of power by the turbine. Note that although energy is not put into the cycle by burning fuel, it is put in by means of the electric motor.

To do this, the air would be introduced under saturated conditions at 63 F to the inlet of the compressor, which would probably be of the axial flow type. The compressor would raise both the pressure and temperature of the air and in so doing would evaporate some of the moisture. Cooling water would be sprayed into the air stream as shown between the compressor discharge and the turbine inlet, and the turbine would take energy out of the air stream, thus helping drive the compressor



Arrangement proposed by M.V.L. to cool 83,000 cfm of saturated air from 63 F to 50 F.

The excess moisture in the air above the saturation value would, of course, precipitate out in the turbine and would be returned by some sort of pumping arrangement to supply air for the sprays in the cooler, also a small amount to the compressor. The air would issue in saturated condition at the discharge of the turbine at 50 F and the water would, of course, be at the same temperature, hence it could recirculate and serve as cooling water in the manner shown.

The problem, therefore, is to find the following values:

Turbine horsepower, motor horsepower, compressor horsepower.

Terminal state of air after compression.

Terminal state of air after cooling in the cooler so that it will emerge at 50 F saturated after expansion through turbine.

Another point is that, whatever method is used to cool the air, it is not needed for continuous operation but only for part-time operation daily. Finally, could the air expansion be carried out at lower cost by using a Venturi nozzle or a Venturi type desuperheater, rather than a turbine, and wasting the energy?

Chicago, Ill. M. V. L.

Question No. 416

WILL ALCOHOL ELIMINATE FOAMING OF BRINE?

WE ARE HAVING trouble with foaming of the brine in our ice cream plant. Several engineers have told me that alcohol will remedy this condition but I am afraid to try it for fear that it will affect the temperature of the brine. Has any one used this method of treatment? How can I eliminate the foaming?

Houston, Texas M. C. J.

Question No 417

WHAT SUPPORTS THE WEIGHT OF THE PISTON?

IN MY DEPARTMENT we have a number of horizontal steam engines for running air compressors, generators, pumps, etc., and I have a controversial question which I would like to present for comments and criticism. What supports the weight of the piston of a steam engine where there is no tail-piece?

It has always been my understanding that the weight of the piston, which varies from 50 to 600 lb or

PRACTICAL ENGINEER SECTION

more, was supported by the adjustments of the crosshead shoe, raising or lowering, to center the piston in the cylinder so that only the rings touch the cylinder walls. Do the throat bearings or packing glands have any part in supporting the piston?

A short time ago we had an outside engineering company come in to overhaul, and put in first-class condition, a 120 hp Harrisburg uniflow steam engine generator. When they were about completed I found that they had done nothing about the throat bearing where the piston enters the steam cylinder. This throat was badly worn out of round at the bottom. This condition had allowed the piston to ride back and forth on the bottom of the cylinder and had worn into the counter bore.

The engineers re-bored the cylinder and put in heavier piston rings. They were a new type of ring which they claimed would hold the piston off the cylinder walls.

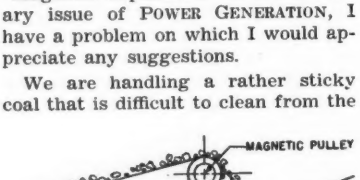
This question has come up before and I have more engineers against me than with me. I claim that the weight of the piston should never be supported by the cylinder walls, but by the adjustment of the cross-head and tailpiece. I also claim that badly worn throats permit the steam pressure to come in direct contact with the piston rod packing and makes it harder to keep a tight rod packing gland.
Trenton, N. J. E. A. N.

Question No. 418

ROTARY BRUSH KEEPS THIS BELT TOO CLEAN!

IN CONNECTION with the article on "Magnetic Separators" in the February issue of POWER GENERATION, I have a problem on which I would appreciate any suggestions.

We are handling a rather sticky coal that is difficult to clean from the



surface of our belt conveyor. Moreover, the rotary cleaning brush knocks off the stray iron fragments held to the belt by the magnetic head pulley, so that magnetic separation is futile. What can we do to remedy this situation?
Chicago, Ill. W. G. H.

Question No. 419

HOW SHOULD HE INSTALL THIS FUSIBLE PLUG?

WE HAVE THREE 150 hp hrt boilers in our dairy plant. Under one boiler we have a small underfeed stoker, and under the other two we have small spreader type stokers. One of these spreader stokers was installed 2 year ago this winter and the other one year ago. I never had any trouble keeping a safety plug intact before we installed these spreader stokers which do, of course operate at somewhat higher ratings. We have had to replace 3 safety plugs in these 2 boilers and 2 in the other one.

I have been complimented during the last two yearly inspections for keeping the boilers clean. I talked this plug problem over with the inspector and he thought there was not enough space between the rear head and the rear wall; this is about 26 in. He suggested bringing a pipe down from the top of the boiler to a certain distance from the top row of tubes near the rear of the boiler. This would be provided with a valve outside of the boiler which could be shut off in case the plug should go out because of low water.

Now I don't recall if he said the plug goes on the bottom of the pipe by the tubes, or on the outside above the valve. I would like to know if there is such a method of using a safety plug and how it is installed. Is it just as safe as a rear head safety plug? This would naturally be a different type of plug; where can we get them?

These stokers have a flyash hopper and venturi and it sure makes a mess in that part of the boiler, to say nothing about starting a few tubes to leak. I have been a reader of your magazine for about 20 or 22 years and would appreciate any help you can give me.
Sandwich, Ill. L. F.

Question No. 420

WHY DOES OIL DISCOLOR IN ONLY ONE AMMONIA COMPRESSOR?

I NEED HELP in solving a problem concerning the emulsification of oil in one of our ammonia compressors.

We have four compressors arranged as in the sketch—two 45 ton, one 10 ton, and one 65 ton—serving a dairy. They are all vertical, twin-cylinder machines driven by synchronous motors. About a week ago the oil glass on the large machine, No. 4, showed the oil in the machine to be the color of buttermilk. I drained the compressor and wiped it out clean and put in new oil. The next day the new oil in this one machine turned to the buttermilk color again. The oil in the other machines, running on the same system at the same time, did not change from the usual heavy brown color.

We have a water tank carrying plain water at 34 F; I suspected water and took a sample up to our chemist who put it in the centrifuge, then heated it and looked at it in a microscope. But he said he was unable to determine what it was. I let the samples set for a couple of days to see if the deposit would settle out, but it didn't, except to look the color of coffee with light cream in it down to about ¼ in. from the bottom and there it looks like coffee with heavy cream in it. It also has a clabby appearance like the clots you see in sour milk.

I now have the No. 4 machine opened up to see if there is any water leaking from the water jacket; but as yet have been unable to detect any. After complete draining, wiping out dry, and filling with new oil, three times in less than one week, the new oil –the same as put in the other machines—turns color in a short time.
Philadelphia, Pa. G. B.

Answer No. 396

HOW DO YOU DISCOVER IF THERE'S ELECTROLYTIC ACTION IN THE BOILER?

THE IMPORTANT point is whether the pitting is most serious above or below the water line. The nature of the feedwater is also important as this acts as an electrolyte and is most active when heated.

There is also the possibility that the boiler is slightly charged due to leakage of electrical currents. It is advisable that all boilers be grounded electrically, preferably by a steel rod welded to the boiler shell and terminating well below the floor level.
Essex, England W. E. WARNER

Answer No. 397

COULD SPONTANEOUS IGNITION HAVE CAUSED THIS EXPLOSION?

SPONTANEOUS COMBUSTION probably caused this explosion. In all compressors there is cylinder lubrication and the oil mist which forms makes an explosive mixture. This can easily be ignited by high pressures or temperatures, particularly if the air is moving at a high velocity.

If charred deposits have been found in the pipe lines it is clear that spontaneous combustion does occur but no accident may result as the pipe line may be able to withstand the additional pressure.
Essex, England W. E. WARNER

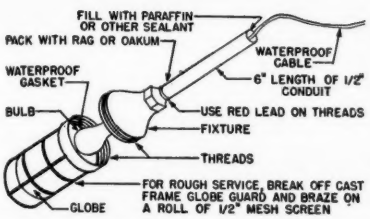
Answer No. 399

SHOULD 115-V EXTENSION LIGHTS BE USED INSIDE BOILER DRUMS?

115-V Extension Lights Okay If Used Properly

IN REGARD to Question 399, there is no legitimate reason why the use of a 115-v lamp on an extension cord into a boiler should be barred or avoided. After all, safety is an alert state of mind. It is not static, and never will be.

Reasonable safety precautions should be taken in the use of all industrial equipment. But to carry them to the point of installing special low voltage equipment when standard low


FILL WITH PARAFFIN OR OTHER SEALANT
PACK WITH RAG OR OAKUM
WATERPROOF CABLE
WATERPROOF GASKET
6" LENGTH OF 1/2" CONDUIT
BULB
USE RED LEAD ON THREADS
FIXTURE
THREADS
FOR ROUGH SERVICE, BREAK OFF CAST FRAME GLOBE GUARD AND BRAZE ON A ROLL OF 1/2" MESH SCREEN
GLOBE

voltage equipment is available seems far fetched. The women and children of half the nation's households use 110-v electrical equipment. To replace it with 32-v equipment is much the same as reducing the speed of automobiles from 30 miles an hour to 5 miles per hour, simply because the latter speed is safer.

From the viewpoint of safety, electrical potential and speed are much alike. As the speed of a car increases, so must the alertness of the driver increase, or safety goes into the ditch with the driver and the car. Likewise, if the voltage of electrical equipment is increased, so must the alertness of the users increase—or else.

If any boiler repair man wants a safety lamp on a drop cord, let him get a standard cold storage vapor-proof lamp fixture, and screw a 6 in. piece of conduit into it for a handle. Use red lead on the conduit threads, and tighten as with pipe. After the cord is connected to the socket, pour any dielectric sealant such as paraffin into the handle around the cord. If the cord is rubber sheathed, paraffin may burn the rubber. Any other common sealant may be used, however.

When screwing in the outer globe and guard, be sure the vapor-sealing gasket is in good condition. The guard frame is usually cast. Therefore, if the lamp is to be handled roughly, break off the bars at the threaded end, and braze on a new protective guard of ½ in. mesh screen. Test by lowering into water, then plugging into any outlet.

When standard 115-v circuits run into so many millions of laundries, lavatories, household water heaters, washing machines, bathrooms and other places where water is far more common than not, let's be sane—and alert.

Marissa, Ill. G. H.

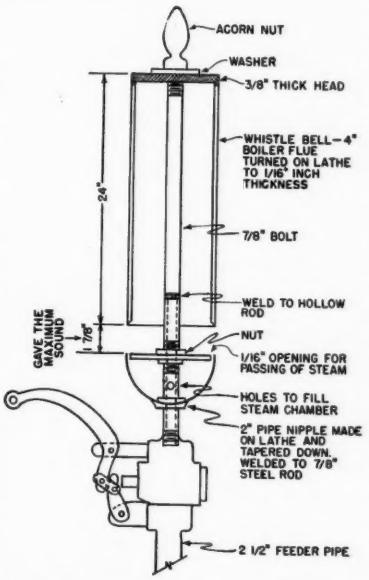
Answer No. 404

HOW CAN HE MAKE THIS WHISTLE LOUDER?

WHILE READING the Practical Engineer in the January issue of POWER GENERATION recently, I ran across the above question by J. W. D. This rather amused me as it reminded me of the time I had trying to make a whistle that would suit the manager of this particular plant.

The sketch shown is the whistle that was finally satisfactory, but it isn't the original. The first was much longer; it was also 32 in. long, if my memory doesn't fail me. We ran into trouble trying to keep it from screeching. It would break into a scream and start to play "ring around the rosy"; so we cut it off to 28 in. Still it screamed!

We then cut it to 24 in. and turned it down to just a few thousands over ⅛ in. in thickness. It was the original boiler flue to start with, which thickness I cannot recall.


ACORN NUT
WASHER
3/8" THICK HEAD
WHISTLE BELL—4" BOILER FLUE TURNED ON LATHE TO 1/16" INCH THICKNESS
24"
7/8" BOLT
WELD TO HOLLOW ROD
GAVE THE MAXIMUM SOUND
7/8"
NUT
1/16" OPENING FOR PASSING OF STEAM
HOLES TO FILL STEAM CHAMBER
2" PIPE NIPPLE MADE ON LATHE AND TAPERED DOWN. WELDED TO 7/8" STEEL ROD
2 1/2" FEEDER PIPE

The first time that we tried it, it came loose from the vibration. We had to weld in a stronger head and this proved satisfactory. As far as I know the old whistle is still calling the men to work. The manager liked it too; he said it reminded him of the Mississippi river boats. No doubt it reminded him of the days of his boyhood spent in the South.

No! J. W. D. of Chicago hasn't an easy job on his hands, as we sure made a lot of adjustments before we found the correct distance from the steam opening for the bell. In the end, 1⅞ in. seemed to be plenty loud and not scream too much.

Oroville, Calif. R. L. B.

Answer No. 410

WHAT METHODS REDUCE MAINTENANCE OUTAGE?

TODAY IN ORDER to reduce outage on plant equipment to a minimum, most operators are working on a program of periodic inspection, and scheduling of hours of operation.

This is really preventive maintenance and is followed out with a fixed schedule. A report is also made stating the condition of the equipment and whether or not any repairs or replacements are necessary.

In conjunction with the inspection of equipment a program of cleanliness is followed out. Clean equipment gives better service and requires less maintenance.

Plant personnel education is another program which is receiving a great deal of attention today. It has been proved that hen the operator understands the "How, Why and Dont's" of a piece of equipment, maintenance and outages are reduced. On each piece of equipment or as close to it as possible is placed a card containing instructions regarding the starting and stopping procedure.

The education, inspection, cleanliness, and instruction card system all are great aids toward the plant safety campaign, and the frequency of disastrous accidents has decreased greatly.

CHARLES H. ELBERT

Irvington, N. J.

Answer No. 412

HOW VALUABLE ARE PULVERIZER RECORDS?

THE ONLY DIRECT operating value in recording these pulverizer temperatures is in the case of an alert operator, who by frequently checking these temperatures on a chart, can quickly detect any variation from normal, and act accordingly. By having a continuous record easily available, a momentary upset that may occur while the operator has his back turned or making his rounds to other locations will be recorded, and be there for the operator to note the next time he checks the chart. Indicating thermometers are of value only so long as the operator is standing in front and looking directly at them.

The indirect operating valve in recording pulverizer temperatures is the very important one of giving warning of trouble that is in the developing stage, often well in advance of actual breakdown. Pulverizing equipment may operate perfectly for months without any apparent difficulty. In most cases, approaching trouble gives definite and obvious signs to those who are alert to such signals. An occasional short increase or decrease in temperature, shown by "pips" on the chart, or a long-time gradual change in temperature often warn of trouble in the making. By investigating as soon as these abnormal changes are seen on the chart, serious difficulty can often be averted.

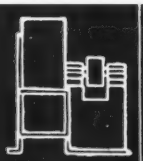
P. M. C. may have seen the same temperatures recorded on the charts day after day, and wondered why several hundred dollars were spent for a recorder to record the same unvarying temperatures seven days a week every week in the year. But some day when the recorder gives the operators a warning of trouble to come, and they are able to avoid a breakdown, he will realize it was money well spent. It is for this reason that most recorders are installed.

WILLIAM C. JUSTICE

Hyattsville, Maryland

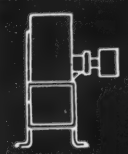
PRACTICAL ENGINEER SECTION

FAN DRIVE ARRANGEMENT AND DIRECTION OF ROTATION



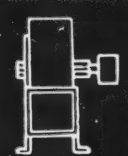
Arrangement No. 1.

For belt drive. Wheel overhung. Bearings on pedestal.



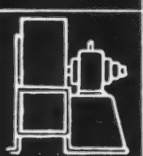
Arrangement No. 2.

For belt drive. Pulley and wheel overhung. Bearings in bracket on fan housing. Made only in smaller sizes for reversible discharge.



Arrangement No. 3

For belt drive. Pulley overhung. Bearings supported on fan housing.

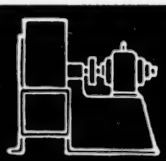


Arrangement No. 4.

For direct drive. Wheel overhung. No bearings on fan. Wheel mounted on motor or engine shaft. Pedestal for motor or engine.

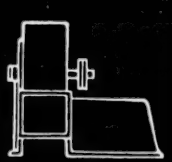
Arrangement No. 5.

For direct drive. Wheel overhung. Includes housing, wheel, shaft, one intermediate bearing, flanged coupling and pedestal only for motor or engine.



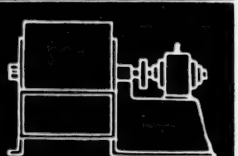
Arrangement No. 6.

For direct drive. Three-bearing arrangement with fan bearing at inlet side. Includes housing, wheel, shaft, one bearing (in inlet), rigid coupling, and pedestal only for motor or engine.



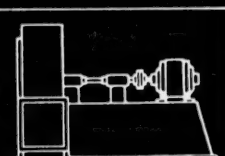
Arrangement No. 7.

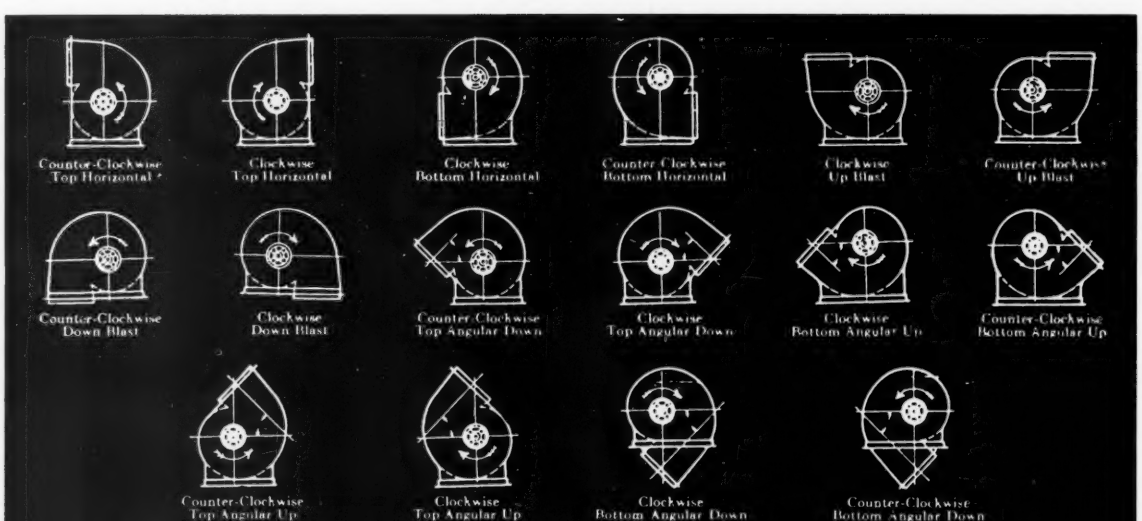
For direct drive. Similar to Arr. 6, but with two bearings on fan, and flexible instead of rigid coupling.



Arrangement No. 8.

Similar to Arr. 5, but with two bearings on pedestal with motor, and flexible instead of rigid coupling.





Direction of Rotation is determined from the drive side for either single or double width or single or double inlet fans. (The driving side of a single inlet fan is considered to be the side opposite the inlet regardless of the actual location of the drive.)

As adopted by the National Association of Fan Manufacturers and reproduced from **Heating and Ventilating's "Engineering Databook"**

Achilles Heel

...INDUSTRIALLY SPEAKING

Legend tells of the supposedly indestructible Achilles and how finally he was slain when an arrow found its mark in his only vulnerable spot—his heel.

Too often in industry today, Production's vulnerable spot is the boiler plant . . . a boiler plant made unprofitable by improper water conditioning.

Correct water conditioning is a matter of careful and scientific control.

W. H. & L. D. BETZ is an organization of engineers and chemists specializing in the solution of all industrial water problems. Years of experience have made Betz water conditioning service scientifically correct . . . complete . . . economical. Our staff of engineers will welcome the opportunity of discussing your boiler water problems . . .

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BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

Practice of Theory vs Theory of Practice

By GEORGE P. REINTJES
President, Geo. P. Reintjes & Company
Kansas City, Mo.

WE ALL LIVE IN A WORLD of theory or disbelief . . . a world in which we hold some things to be true, others false. It was theory which led to the production of the "Atomic Bomb", and many other far-reaching developments in our history. But, must we as engineers look upon all theories as being facts?

For instance, consider the heat enclosures surrounding the fires of today's industrial furnaces and boilers. Theoretically, the heat transferred through a refractory wall can be calculated to the nth degree by formulae, curves and graphs found in many textbooks and technical writings.

But, in practice there is a different story. The theories are as vulnerable when subjected to the fires of practical service as is the paper on which the charts and curves are printed. We have talked to owners of wall enclosures after they have purchased a specific enclosure because of the salesman's elaborate sales presentation with theoretical . ' transfer charts. It reminds us of a gentleman who recently purchased one of today's "low priced" "low-mileage" used cars. After a few days his troubles started and he returned to the used car lot where he cornered the salesman who sold him the car and said, "Won't you give me that sales talk all over again, I'm weakening".

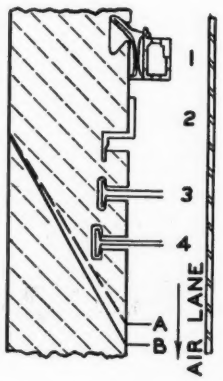
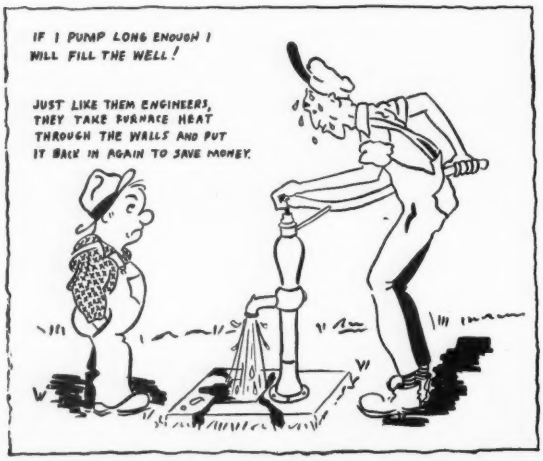
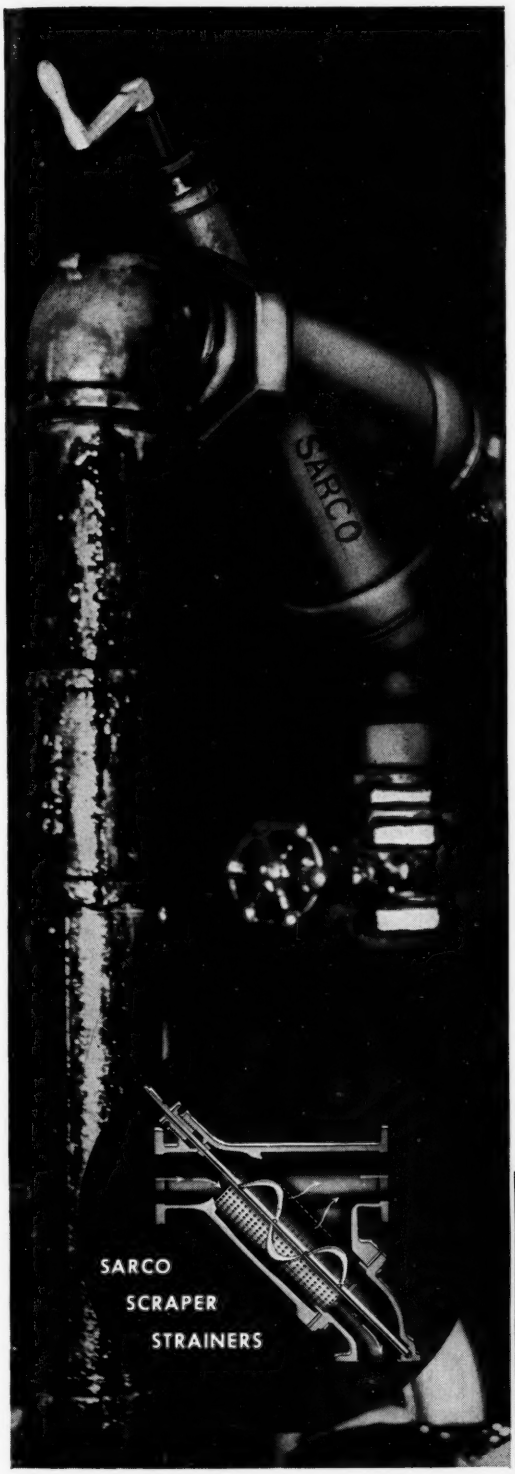


Fig. 1 Chart showing uniform temperature throughout refractories on insulated walls.
Curve A shows temperature gradient for 1200 ft. per min. air flow.
Numbers 1, 2, , and 4 show depth penetration of castings of four recognized suspended walls. The amount of metal absorbing heat and transferring it to the air lane varies as much as 500 per cent.

On some occasions, theory-minded purchasers have told us that Reintjes walls were not being considered because we did not misname them "air-cooled" walls. In fact, the temperatures of air in the airlanes back of Reintjes suspended walls were not as high as those in so-called air-cooled walls (Fig. 1). Therefore, other walls were better cooled! This is simply misinterpretation of theory, as the rate of heat transfer through any refractory wall of given thickness whether suspended by one method or another, is still the same refractory and therefore has the same temperature drop. Consequently the temperatures in the air lanes, under the same conditions, should be identical. However, the metal which supports the refractories transfers heat forty-five times faster than refractories. It is obvious that the more metal embedded within refractories, and the greater the depth the metal is embedded, the greater will be the heat flow through the wall to be dissipated in the air lanes. So you have more heat "to put back into the furnace". This is like trying to pump a well dry while you put the water right back in again (Fig. 3).


IF I PUMP LONG ENOUGH I WILL FILL THE WELL!
JUST LIKE THEM ENGINEERS, THEY TAKE FURNACE HEAT THROUGH THE WALLS AND PUT IT BACK IN AGAIN TO SAVE MONEY.

MY COFFEE POT HAS GOT A WOODEN HANDLE, THE OLD IRON HANDLE USTER BURN MY HANDS.
IF IRON BURNS YOUR HANDS, THEN WHY DO YOU PUT AN IRON CASING ON YOUR BLER SETTINGS, UNLESS YOU WANT TO COVER UP YOUR BUM WORK!



Three troublesome PROBLEMS SOLVED with Sarco in this Oil Plant

Years of experience and research go into every barrel of special lubricating oils shipped from this plant. As a final insurance against mechanical impurities, every quart of oil passes through a Sarco Scraper Strainer just before it enters the container.

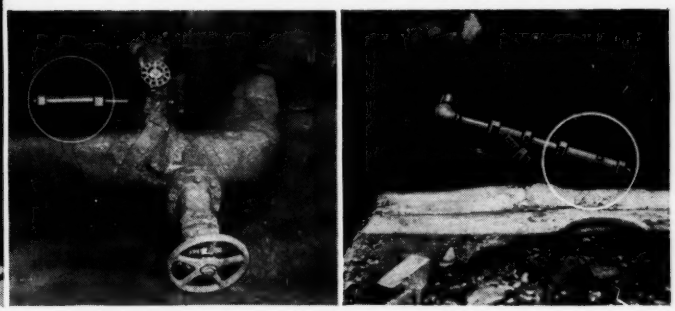
Every few hours a turn of the handle at the top cleans the strainer screen. No messy basket to be lifted out, no exposure of the liquid to atmosphere and no lost time. Sarco Scraper Strainers are available in sizes from ¾" to 8", hand or motor operated. Ask for Catalog No. 1225.

OUTDOOR TANKS: To insure flow of oils from outdoor tanks, even in the severest weather, the Sarco 87 Trap-Control is used. Temperatures are kept at predetermined points by this inexpensive device which cannot freeze.

PUMP HOUSE HEATING: Another application of the Sarco 87. It keeps heating coils in the outside pump house at correct temperatures. No steam is wasted. In other forms this inexpensive regulator is used for wash tanks and process equipment. Ask for Catalog Nos. 250 and 550.

183

SARCO 87 STEAM TRAP CONTROL



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Represented in Principal Cities
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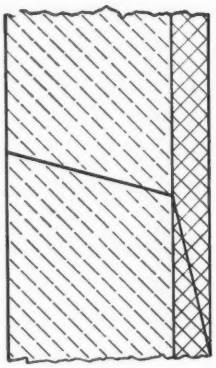


Fig. 2 Showing temperature gradient through refractories with no air velocity in air lane. These curves are drawn from data contained in Bulletin 334 of the Bureau of Mines.

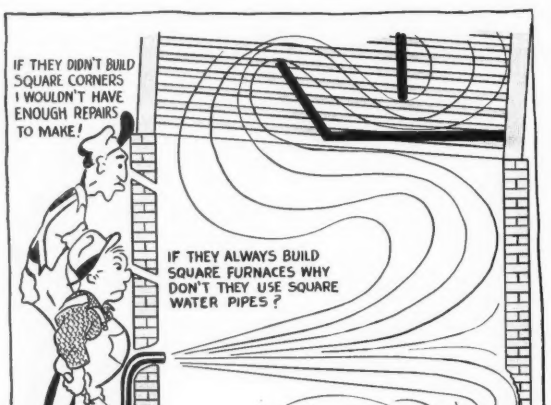
We have heard of ambitious wall salesmen who claim they have charts and formulae for calculating increased efficiency to be obtained by taking heat out of a furnace and putting it back again; we believe these same charts can be used to prove that a man can raise himself up off the floor by pulling on his bootstraps. In practice, however, it is a different thing. The common sense solution to the problem is to insulate the refractories and keep the heat within the furnace in the first place. In so doing, you avoid internal strains within the refractories; you keep the furnace side of the refractories at a more constant temperature by insulating the back of the refractory wall (Fig. 2). This treatment not only lengthens service life of the refractories, but allows the enclosure to function as it was intended . . . to keep heat within the furnace.

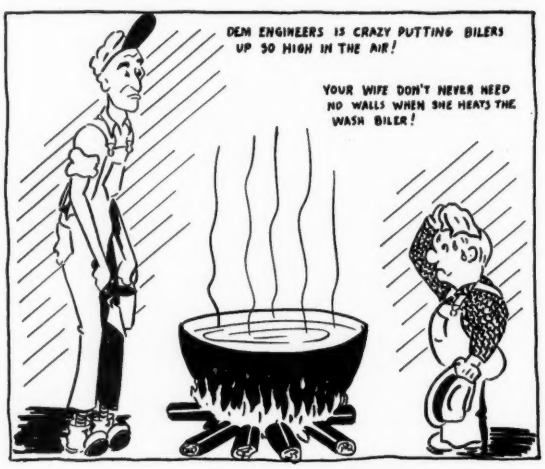
Insurance companies must think of all possibilities to keep from losing money on their risks. And in their endeavor to keep the ultra-curious individuals from getting their fingers burned, desire that the casing temperature, above all else, be kept at a temperature below 140 F. Accomplishing this is not easy, especially if the casing is steel. The more dense the casing materials, and the more polished the surface, the lower the temperature required for blistering the fingers. For a polished steel casing with 120 F. temperature is as hard on the hands as a casing of insulation which registers 150 F. (Fig. 4).

Theoretically, it is an easy matter to calculate how much insulation should be applied behind heated refractories to keep a metal casing down to 140 F. But the difficulty occurs when the walls are filled with door openings. Metal doors and frames usually register between 400 F to 800 F. Since the metal door frames are attached directly to the metal casing, what happens? You guessed it; the heat goes around the insulation and is dissipated in that nice, wide expanse of metal casing. The theories were right, but practice nullified them. Not so long ago we examined a furnace enclosure and noticed that the temperature of the metal casing behind the furnace area was less than 140 F., while the internal temperature was approximately 2500 F. But back of the third pass in the boiler where the temperature within the walls was only 600 F., the casing temperature was sufficiently high to burn off a first grade paint. The entire wall was the same construction, we noted, and further investigation proved that the casing plates were connected to the air heater behind the boiler. The builder of this air heater had neglected to insulate the air heater and consequently, the heat was transferred to the connected wall casing and burned off the paint.

Occasionally the causes of a casing being too hot are difficult to locate. One time, we found that the casing of a boiler was above the allowed 140 F. and after exhausting examination we learned that the cause was heat radiating from the doors and piping of an adjacent boiler. On another installation, improperly insulated piping heated the casing. In oil or gas fired boilers, the contours of the floors of the boiler can effect the temperature of the casing as much as 50 F. If the furnace is squared or box type, the gases from the burners shoot back toward the rear wall of the boiler. A portion of the gases eddy downward, heating the lower portion of the side rear walls and the floor. However, if the floor is contoured so as to turn the gases upward and toward the boiler tubes with the least effort and avoiding all back eddies, that extra amount of heat is available for absorption by the tubes (Fig. 5). In oil or coal fired boilers, if the soot blowers are not keeping the tubes clean, the boiler is slow in absorbing the heated gases and the walls are punished, the casing temperature rises as a consequence. Too, operators sometimes keep the damper partially closed to lower the stack temperature. This makes a retort out of the furnace and the walls absorb an undue amount of heat. Design of baffles has a great deal to do with temperature of casings. On two Stirling boilers we recently changed the countours of the baffles. In doing so, we increased the heat absorption of the boiler tubes and at the same time reduced the pressure drop through the boiler by more than 50 per cent. Reducing the pressure drop automatically increases the stack capacity, and at the same time increases the velocity of the gases and the rapidity to which the heat can be absorbed.

In building boiler settings and furnace enclosures, much food for thought can be found in Joseph Hay's cartoon in a book on furnace building, caption of which is, "Eb Hawkins spent a lot of time pegging down the fence to keep the little pigs in, but forgot that the durn gate was off it's hinges". It's the same in furnace enclosures; the greater amount of metal used in supporting the wall, and the


IF THEY DIDN'T BUILD SQUARE CORNERS I WOULDN'T HAVE ENOUGH REPAIRS TO MAKE!
IF THEY ALWAYS BUILD SQUARE FURNACES WHY DON'T THEY USE SQUARE WATER PIPES?


DEM ENGINEERS IS CRAZY PUTTING BILERS UP SO HIGH IN THE AIR!
YOUR WIFE DON'T NEVER NEED NO WALLS WHEN SHE HEATS THE WASH BILER!

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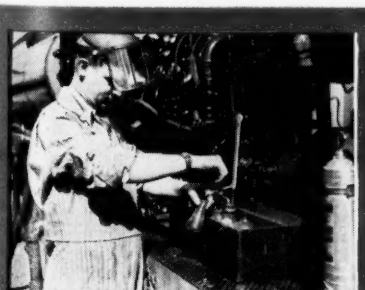

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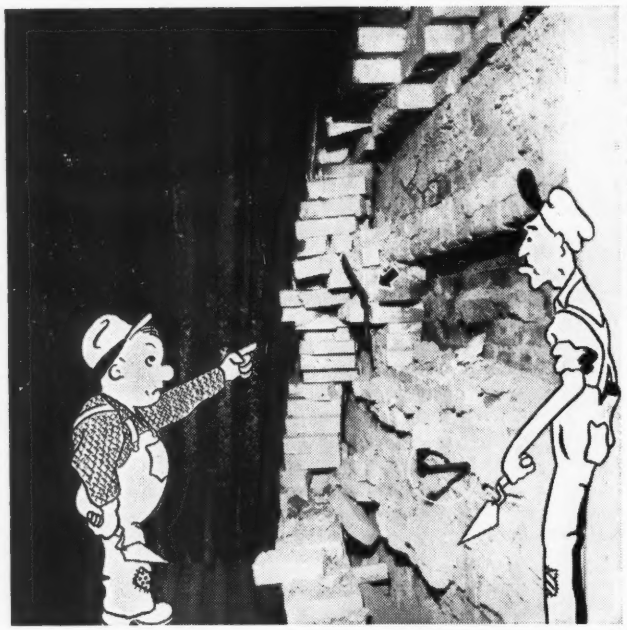


Fig. 7 Johnathon: "Lem, why did you build a wall of red brick and fire brick?"
Lem: "To save them money and building a wall where they could not see any cracks."
Johnathon: "But the fire brick fell in."
Lem: "I can't understand it. I put bolts through the wall to hold it and I cemented down the red brick so that when the fire brick expanded they couldn't push the red brick upward."
Johnathon: "Lem, the bricks from the wall look new—you just put it in not so long ago, but all the tie bricks are broken off."
Lem: "If I didn't build it so the tie brick would break off, I would have cracks on the outside. Nobody ever looks at the middle of the wall."

closer this metal to the heated face of the refractories, the greater should be the temperature in the airlanes.

There are odd happenings in the furnace enclosure industry which keep us all from growing old. Some years ago, we received a rush call from one of the country's major automobile manufacturers for whom we had recently installed a Reintjes suspended wall boiler setting. The boiler room superintendent was on the phone, frantically exclaiming he feared the walls would collapse. The boiler was then only operating at about 50 per cent of its normal rating, yet the temperature of the brick casing outside the newly installed wall was hot enough to fry an egg. A boiler across the aisle with a competitive enclosure was operating at about 200 per cent rating and its casing was comparatively cool. The knowledge that the competitive wall was suspended with castings either 100 per cent embedded within, or in direct contact with the heated refractories . . . and the fact that the Reintjes wall was suspended with but 3 per cent of the castings embedded within or in direct contact with the heated refractories, seemingly threw all theories of heat transfer out of the window. Further examination proved that walls on the interior of the boiler operating at 50 per cent rating were white hot, while the interior walls of the competitive setting at 200 per cent rating were only cherry red. A decision had to be made, and with unwavering faith in the Reintjes construction, we instructed the operator to raise the rating slowly to 200 per cent. Then an unusual thing happened. Instead of the casing temperature increasing as the rating increased, as would be the usual circumstance, the temperature of the casing cooled off to a point actually lower than that of the casing of the competitive setting across the aisle. Finally it was discovered that there were large openings into the furnace at the side of the wind box, and consequently no air was circulated back of the walls at the reduced rating. Further examination disclosed that when the burner men closed the openings in their "wind box", this air flowed downward in our air lane, heating of casing did not reoccur.

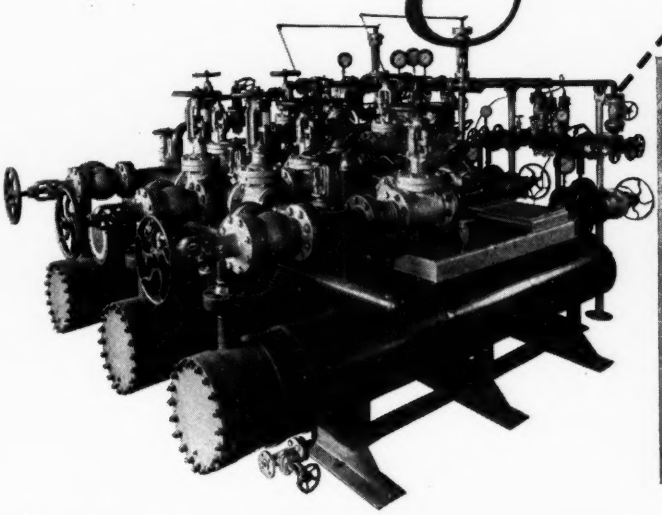
Even after the discovery was made, we felt it advisable to watch the boiler performance of the rest of the day, and at 5:00 o'clock when the fires of both boilers were extinguished, the walls of the Reintjes setting still showed coloring from heat an hour later, while the walls of the competitive setting cooled immediately. Today, after ten years of service, the same holds true, and incidentally, the motor company has not spent one cent for repairs on the Reintjes setting.

Both theory and practice agree that to cool the furnace face of a refractory, you must have air infiltration through the refractory into the furnace. Thus, the more leaks through a wall into the furnace, the cooler will be the air in the air lanes. This, of course, is assuming that the boiler is operating at a minus pressure. If, on the other hand, there is a positive pressure in the furnace, then the reverse is true, the heated gases leak into the airlane. This is a frequent cause of overheating a casing, especially on large power boilers. Minus pressure is not uniform throughout the furnace. It is least in the furnace proper, and as gases cool behind the tubes, a semi-vacuum is created. Consequently there is a greater differential pressure behind the boiler tubes and more opportunity for gases to short circuit through the air lanes and re-enter the boiler nearer the gas outlet. The practice of cooling the heated boiler tubes with excess air infiltration is very, very costly.

Frequently, reports have come to us that a particular boiler setting has given excellent service for twenty or more years. And it is quite true that the ordinary setting of thirty to fifty years ago, even though made of

(Continued on page 136)

World's Largest



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- ALL PARTS VISIBLE AND ACCESSIBLE for easy operation, maintenance and repair.
- PUMPS AND HEATERS are interconnected to provide maximum flexibility of operation.
- SAFETY VALVES protect individual parts where required.
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- PUMPS OPERATE AT MODERATE SPEED. Heaters designed to give the correct viscosity and velocity without fouling.
- SMOOTHER FLOW OF CLEAN FUEL TO FURNACE. Air chamber for each piston pump prevents pulsations — pressure regulator for rotary pumps. Twin type strainers provided to keep atomizer tips from clogging.
- CLEANER BOILER ROOM . . . all overflows connected to a common outlet; flanged drip pan catches oil drip.

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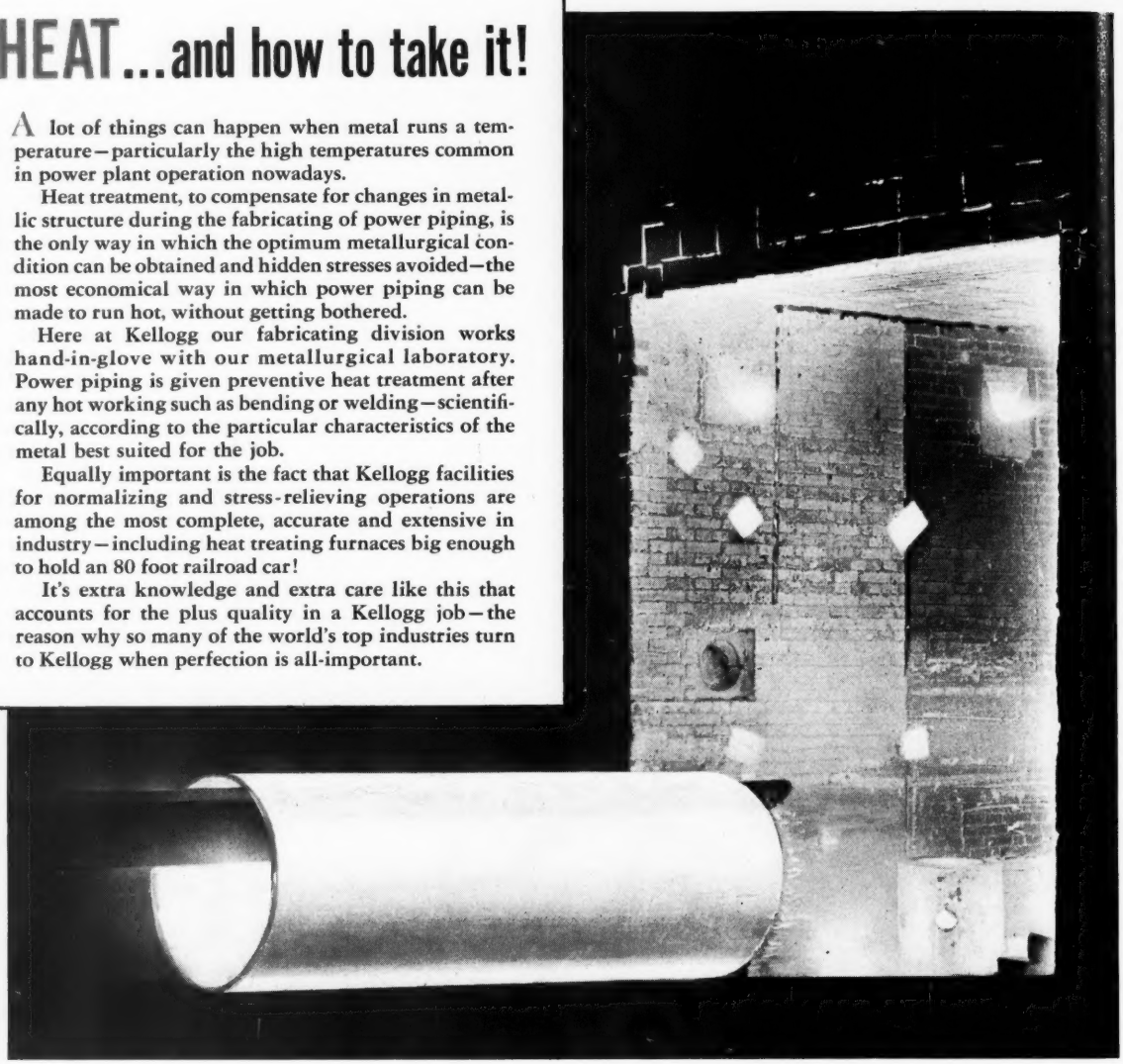
A lot of things can happen when metal runs a temperature—particularly the high temperatures common in power plant operation nowadays.

Heat treatment, to compensate for changes in metallic structure during the fabricating of power piping, is the only way in which the optimum metallurgical condition can be obtained and hidden stresses avoided—the most economical way in which power piping can be made to run hot, without getting bothered.

Here at Kellogg our fabricating division works hand-in-glove with our metallurgical laboratory. Power piping is given preventive heat treatment after any hot working such as bending or welding—scientifically, according to the particular characteristics of the metal best suited for the job.

Equally important is the fact that Kellogg facilities for normalizing and stress-relieving operations are among the most complete, accurate and extensive in industry—including heat treating furnaces big enough to hold an 80 foot railroad car!

It's extra knowledge and extra care like this that accounts for the plus quality in a Kellogg job—the reason why so many of the world's top industries turn to Kellogg when perfection is all-important.



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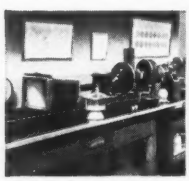

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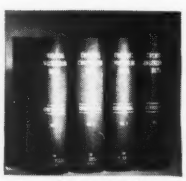

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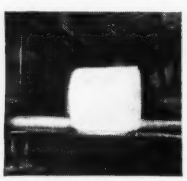

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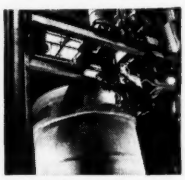

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as a common sense means of Fuel Conservation?

The ability of the United States to assure its security and maintain its position of leadership in the world depends ultimately upon its fuel reserves. Misuse of these vital resources can mean decline and disaster.

Nearly 99% of this country's known fuel reserves is in the form of coal. The United States has all the coal it needs for many generations to come. The reserves of other fuels, however, are being exhaused at an alarmingly increasing rate, largely because they are being used to do certain jobs which coal can do as well or better.

One of the major causes of this unsound state of affairs is the public demand for convenient, "push-button" heat that is clean, efficient and labor-free. To meet this demand, non-solid fuels are being extravagantly misused in ordinary heating in spite of the fact that they are urgently needed for other essential purposes. Coal, properly used, can provide everything the public demands in the way of "push-button" heat.

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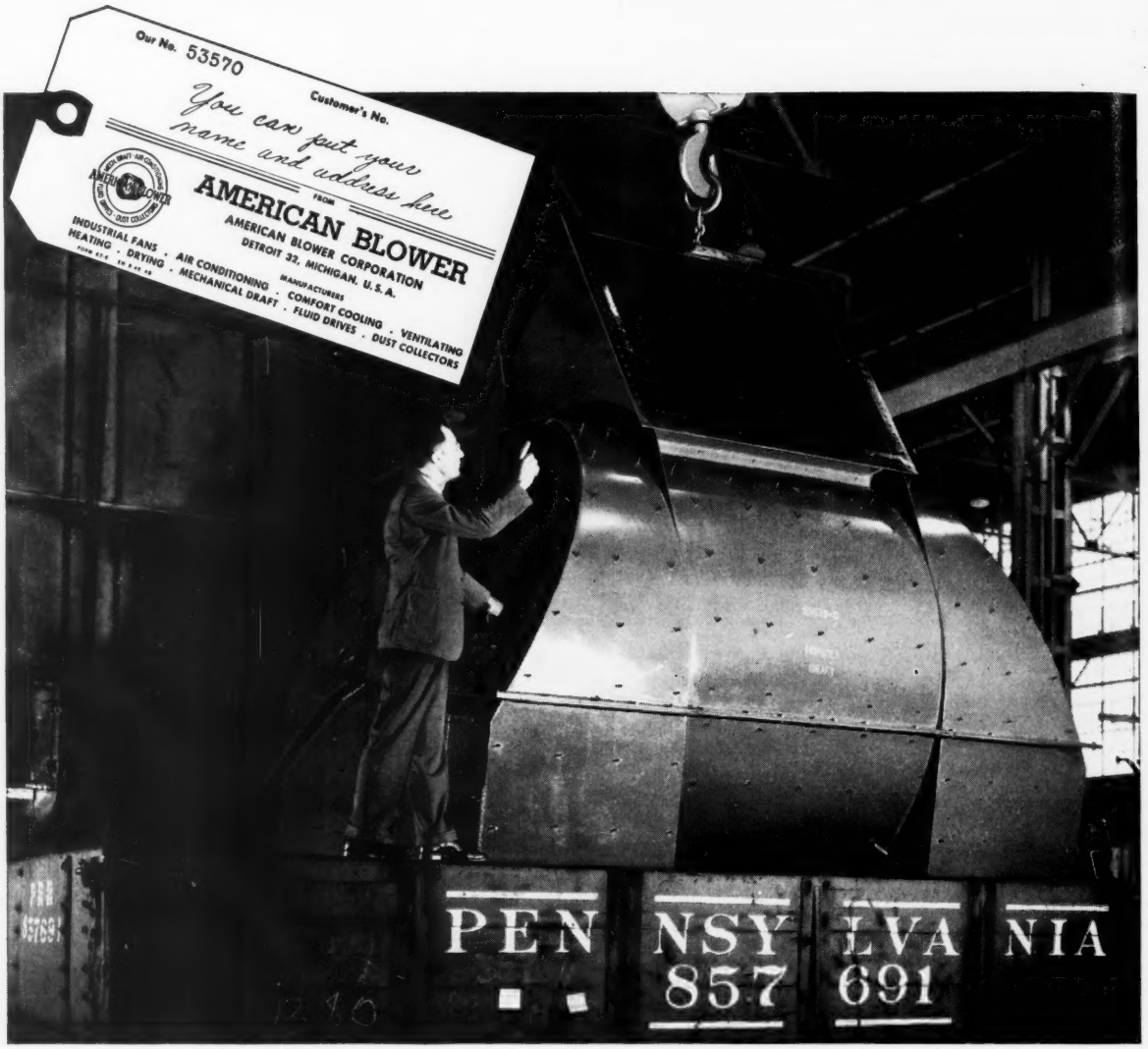
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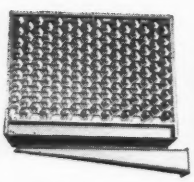

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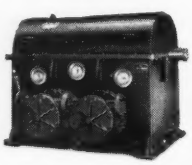

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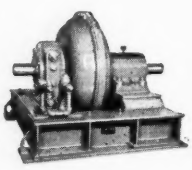

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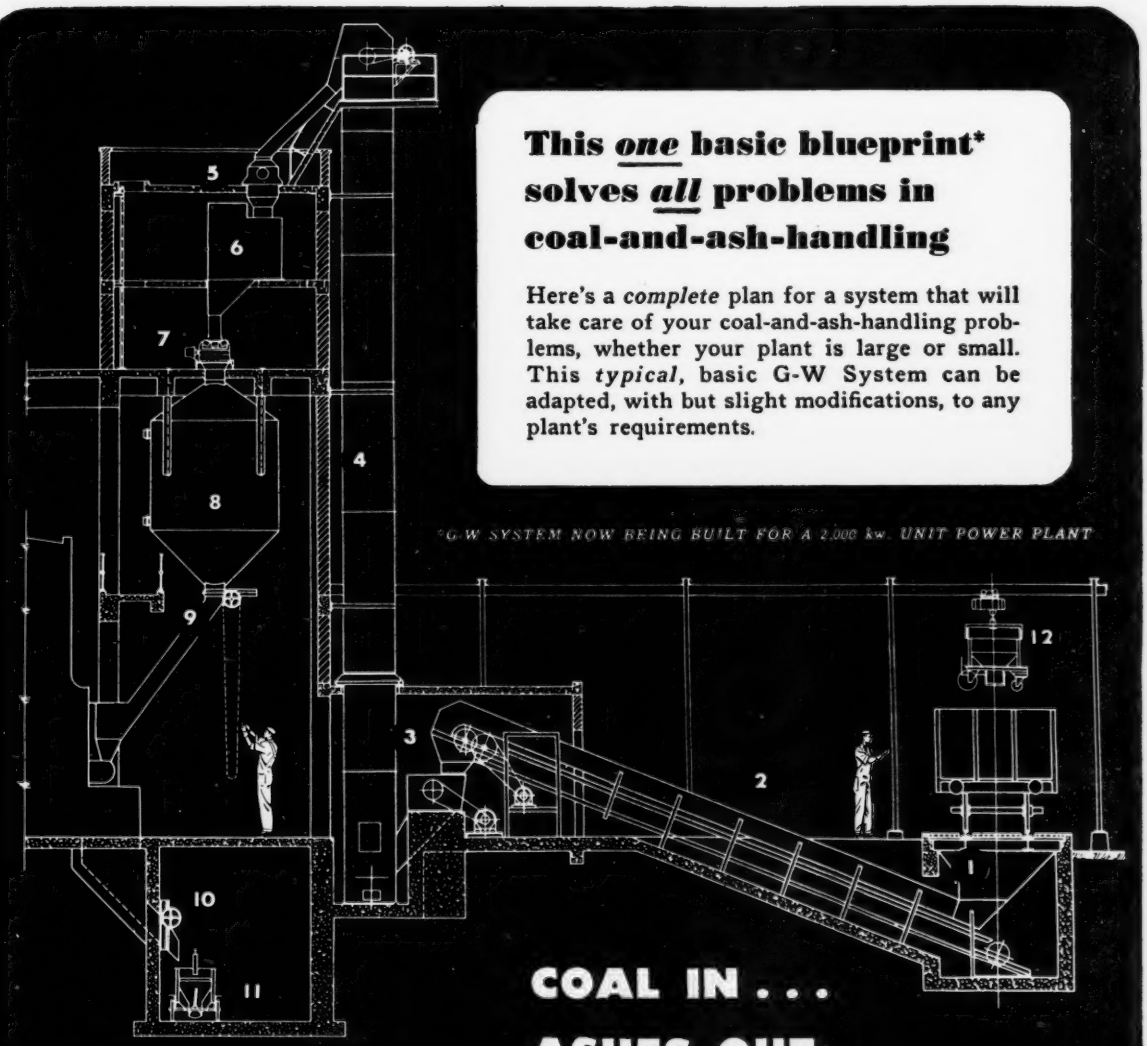

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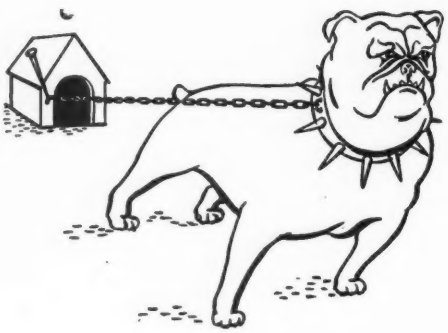
1. Coal passes through *Grating, Hopper* and *Control Gate* to feeder pans.
2. *Apron Feeder* draws coal from hopper, conveys it at uniform rate to crusher.
3. *Crusher* delivers stoker-sized coal to elevator boot.
4. *Bucket Elevator* discharges coal to surge hopper.
5. *Surge Hopper Control Unit* assures constant supply to scale.
6. *Scale* automatically weighs, records and discharges to shuttle belt conveyor.
7. *Shuttle Belt Conveyor* serves several bins from central weighing point.
8. *Storage Bins* have coal level control.
9. *Control Gate* and *Spout* to stoker.
10. *Ash Unloading Gate.*
11. *Ash Cart* manually operated through tunnel.
12. *Ash Cart* electrically operated for ash disposal.

G-W HANDLES IT . . .
faster • easier • cheaper

SINCE 1814

The "Uni-Matic" Oil Purifier is like a WATCHDOG



A DE LAVAL Oil Purifier is always mechanically alert for trouble. Operating on continuous by-pass, it keeps the turbine lubricating oil clean and free from impurities and moisture which normally get into the system. These impurities and water tend to form sludge, so that the Purifier literally helps to prevent sludge formation. Equally important in an emergency is the fact that if an unexpected major water leak develops, the De Laval Purifier can continuously dehydrate the oil and thus prevent serious damage to the turbine.

The "Uni-Matic", the type of De Laval Oil Purifier most generally used, provides a complete oil purification plant, compact and fully enclosed. It includes pumps, gages, and all necessary accessories for keeping oil in the best possible condition. The machine is direct motor driven, self-lubricated, and ball-bearing equipped. The bowl in which purification takes place by centrifugal force is self-draining and of the "constant efficiency" type.

- Write for Bulletin TO-1.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL

LUBRICATING OIL PURIFIERS

Test your reputation at 1050° F

These Taylor Forge stainless steel return bends were manufactured recently for an extreme high temperature operation in an Eastern power plant. The double-long radius, 6-inch return bends are of Stainless Type 347 steel, in Schedule 160 wall thickness, and are the first of their kind to be made available to the power station field.

This is not the first time Taylor Forge has been identified with unusual "firsts." These fittings are operating at 1050° F temperature and 1500 pounds pressure. Naturally, the manufacture of *safe* fittings for such conditions *demands and gets* complete mastery of forging techniques, which is part of our daily job. That is why more features that count are combined *only* in WeldELLS and other Taylor Forge welding fittings. That is why Taylor Forge welding fittings, available in a wide range of types, sizes and metals, are so universally preferred for the most critical conditions.

WeldELLS *have everything*

They alone combine these features:

- **Seamless** — No question about soundness in a fitting that is forged and formed seamless.
- **Tangents** — Keep weld away from zone of greatest stress — simplify lining up.
- **Precision quarter-marked ends** — Expedite layout; insure accuracy. A constructive refinement.
- **Complete identification**—Permanent type; saves time; prevents errors.
- **Wall thickness never less than specification minimum** — Assures full strength and long service life.
- **Machine tool beveled ends** — Provides *the best* welding surface; accurate bevel and land.
- **Full line**—The most complete line of welding fittings and forged steel flanges in the world—greatest range of types, weights, sizes.

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☐ Send your latest data on *Stainless Steel* Welding Fittings and Flanges.

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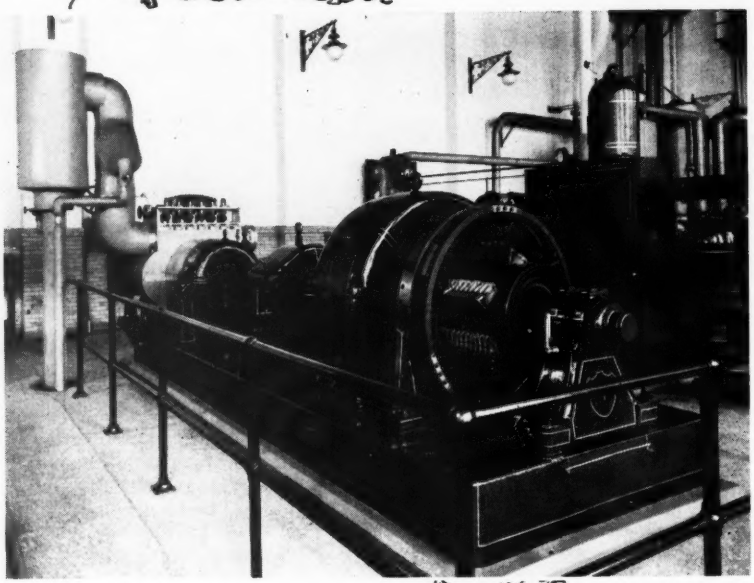
503 0648

This veteran has been PAYING a bonus for years!



The Worthington installation at the Oak Forest, Illinois, Infirmary. The 600kw geared direct-current turbine-generator is non-condensing, operating on steam at 150 lb initial pressure, 0 deg F superheat, and exhausting to 3 lb back pressure.

A Worthington Turbine-Generating Unit That Soon Earned Its Purchase Cost

Take a look at a gilt-edged investment in power! The Worthington Turbine-generating unit shown here was installed in the Oak Forest Infirmary, Cook County, Illinois, almost ten years ago. Besides generating electric power, the turbine supplies exhaust steam for heating water, cooking, baking and to heat various buildings. No live steam direct from the boilers is used for heating because, like the turbine-generating unit, most of the auxiliaries such as pumps and fans are steam driven.

Since installation this Worthington unit has operated continuously without attention — except for routine inspection.

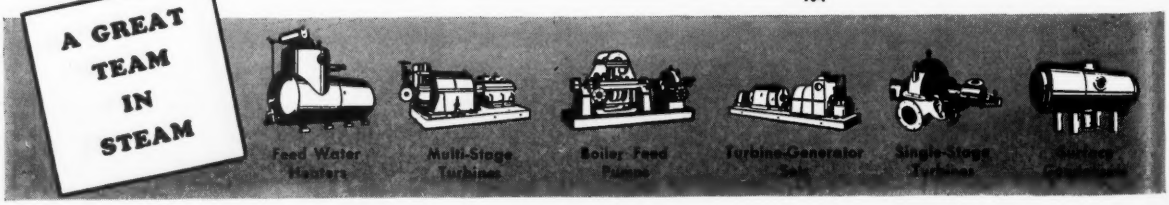
The Infirmary's engineers estimate that by running their own plant — instead of purchasing power outside, and generating steam only for heating — the resultant savings have paid for the Worthington unit several times over.

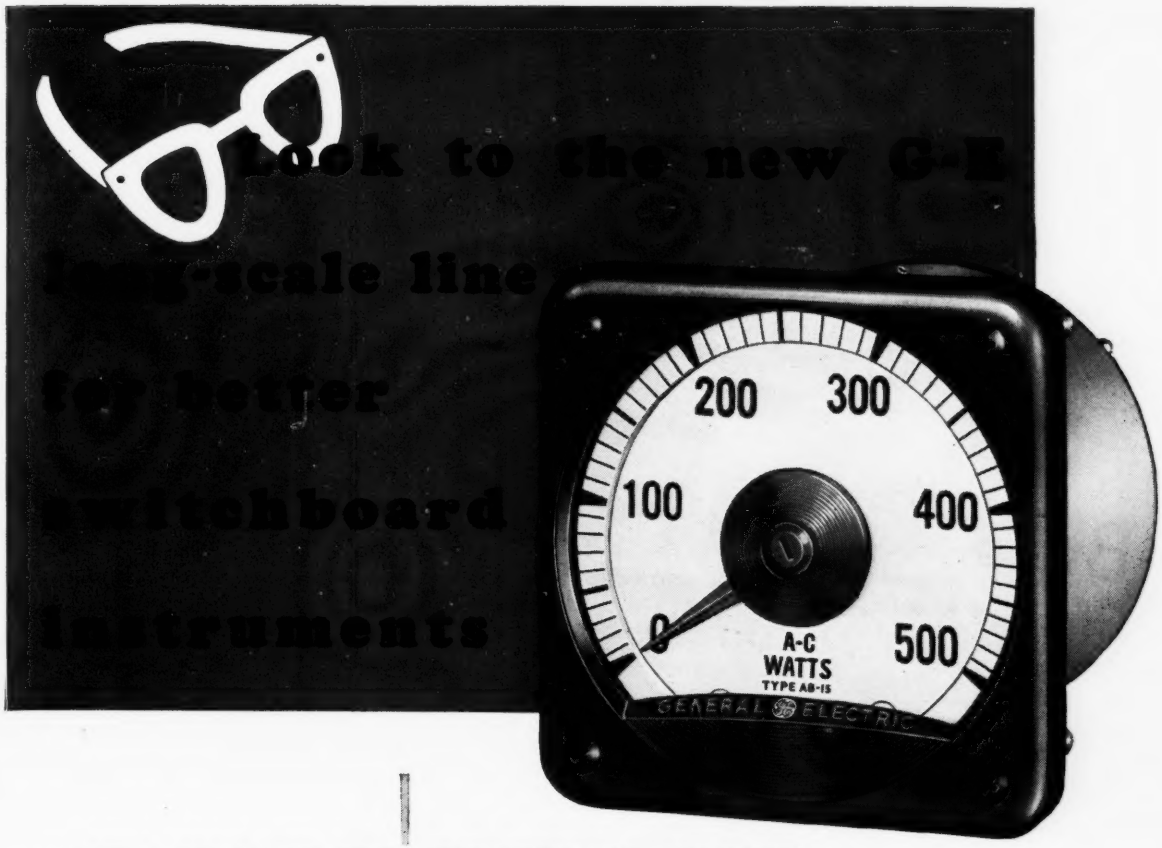
When YOU Buy Turbine Power ... make sure you're getting the lasting economy and efficiency that proves *there's more worth in Worthington.* For further information, including expert technical advice on power problems, write to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.*

T8-1

WORTHINGTON

A GREAT TEAM IN STEAM





MODERN APPEARANCE, BETTER READABILITY, AND ADVANCED MECHANICAL DESIGN HIGHLIGHT THE NEW G-E LONG-SCALE LINE OF SWITCHBOARD INSTRUMENTS. SEE HOW THESE FEATURES LEND INCREASED ATTRACTIVENESS AND OPERATING EFFICIENCY TO YOUR SWITCHBOARD.

Why settle for less when you can get all these features coupled with the many other refinements found in all G-E Instruments? Insist on the G-E long-scale line, and be sure of the best. Ask your nearest G-E sales office for further information on these AB-15 (a-c) and DB-15 (d-c) switchboard instruments . . . .

A-C Ammeter
A-C Wattmeter
A-C Voltmeter
D-C Voltmeter
D-C Ammeter
Frequency Meter
Power-factor meter
Temperature Indicator
Synchroscope

QUICKER, MORE ACCURATE READING—Long (7.1 inch) scale spans 250 degrees, with all numerals upright. Circular mask covers mechanism at center of dial, emphasizing scale and pointer.

MODERN, STREAMLINED APPEARANCE—Attractively styled black Textolite case, designed for semiflush mounting.

STURDINESS—Spring-mounted jewels provide maximum protection for pivots.

EASE AND ECONOMY OF SERVICING—Assured by new unit design. Entire moving mechanism can be removed without disturbing calibration.

OTHER IMPROVEMENTS ARE—

Added compactness from self-contained potential resistance in transformer-rated instruments.

Space saved. Small size—only 4¼ inches square—permits mounting five instruments side by side on a panel only 24 inches wide.

One-per-cent accuracy. Antiparallax scale and pointer plus antiglare glass permit readings from any angle.

Bulletin GEC-218 gives more details. Apparatus Department, General Electric, Schenectady 5, N. Y.

GENERAL ELECTRIC

660-127

BY "heat" we mean anything to 1600°F., for steel-industry use on all types of furnaces and stacks has proved THUR-MA-LOX Number 7 surfacing effective over that range of metal temperature.

Yet THUR-MA-LOX, unlike many heat-resistant coatings, protects at low temperatures, too, just as it does at high.

For instance, a THUR-MA-LOX-coated stack may be taken out of service at red heat and allowed to cool in sub-zero winter cold with no effect whatever on its corrosion-resistant qualities. Or it may be allowed to stand for an indefinite time after coating before being subjected to high heat, or even to any temperature above atmospheric.

The reason is that the protecting pigments of THUR-MA-LOX are sealed to metal not by one vehicle, but by two. The first is effective at low temperatures before high heat; the second takes over for upper-bracket readings and stays on the job for any subsequent dips to lower temperatures.

Together they make a good team — one you can really count on for the type of application where everything else has failed.

THUR-MA-LOX Number 7 is black—weather-resistant—effective to 1600°F. Its companion coating, THUR-MA-LOX Number 10 Aluminum will give you the same long-lasting protection in sheltered locations to 1200°F.

DAMPNEY maintenance for metal

THE DAMPNEY COMPANY of AMERICA • Hyde Park, Boston 36, Mass.

JAMES A. POWELL

JAMES A. POWELL, chief mechanical engineer of Stone & Webster Engineering Corp., died very suddenly at his apartment in the Copley Plaza Hotel, Boston, Mass., on June 9. Mr. Powell, whose permanent home was Wyomissing Hills, West Lawn, Pennsylvania, was born in Raleigh, North Carolina, December 24, 1888. He was graduated from the North Carolina State College with the degree of B.E. in 1908 and was awarded the M.E. degree three years later. Mr. Powell was also awarded an honorary degree of Doctor of Science, in 1933.

After a brief employment as a

James A. Powell

structural draftsman in the office of H. P. S. Keller in Raleigh, he became an apprentice engineer with the Westinghouse Machine Co. in Pittsburgh, assuming the title of engineer in 1913. In 1917 he was employed as mechanical engineer by W. P. Barstow Management Association and a year later became assistant manager and chief engineer of the Elliott Co. He returned to the Barstow organization a year later as assistant chief engineer and vice president. In 1933 he became vice president and assistant chief engineer of E. M. Gilbert Engineering Corp. and in 1938 vice president of The Utility Management Corp.

In 1941 he went to Boston as mechanical engineer for Stone & Webster Engineering Corp. and became chief mechanical engineer in 1945.

Mr. Powell achieved an international reputation as a designer of steam power plants, including notable installations throughout the United States and in the Philippines. He held numerous patents on power station equipment. Mr. Powell represented the United States at the last World Power Conference in Berlin. He was a member of ASME, AIEE, NSPE, and the State Professional Societies in Pennsylvania and Massachusetts, as well as the Engineers Club of Boston. He was a member of the Council of Engineering Societies of New England, Inc.

PERCHED HIGH ATOP A BUILDING
YET
GUARANTEED TO WITHSTAND HURRICANE WINDS UP TO 100 MILES PER HOUR
C. H. Wheeler Water Cooling Towers are guaranteed against winds up to 100 miles per hour, those above 75 m.p.h. being considered hurricane velocity. The United States Weather Bureau tells us that "except in connection with tornadoes and tropical hurricanes, wind velocities in excess of 100 m.p.h. are relatively infrequent in the United States." Guaranteed wind resistant construction, plus guaranteed water cooling performance, efficient operation with minimum water losses and over 50 years' experience are reasons why you should prefer C. H. Wheeler Cooling Towers. Photo shows a tower with steel casing and redwood fill. Send for Catalog 145.
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REPRESENTATIVES IN MOST PRINCIPAL CITIES
WATER COOLING TOWER
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STEAM CONDENSERS · AIR EJECTORS
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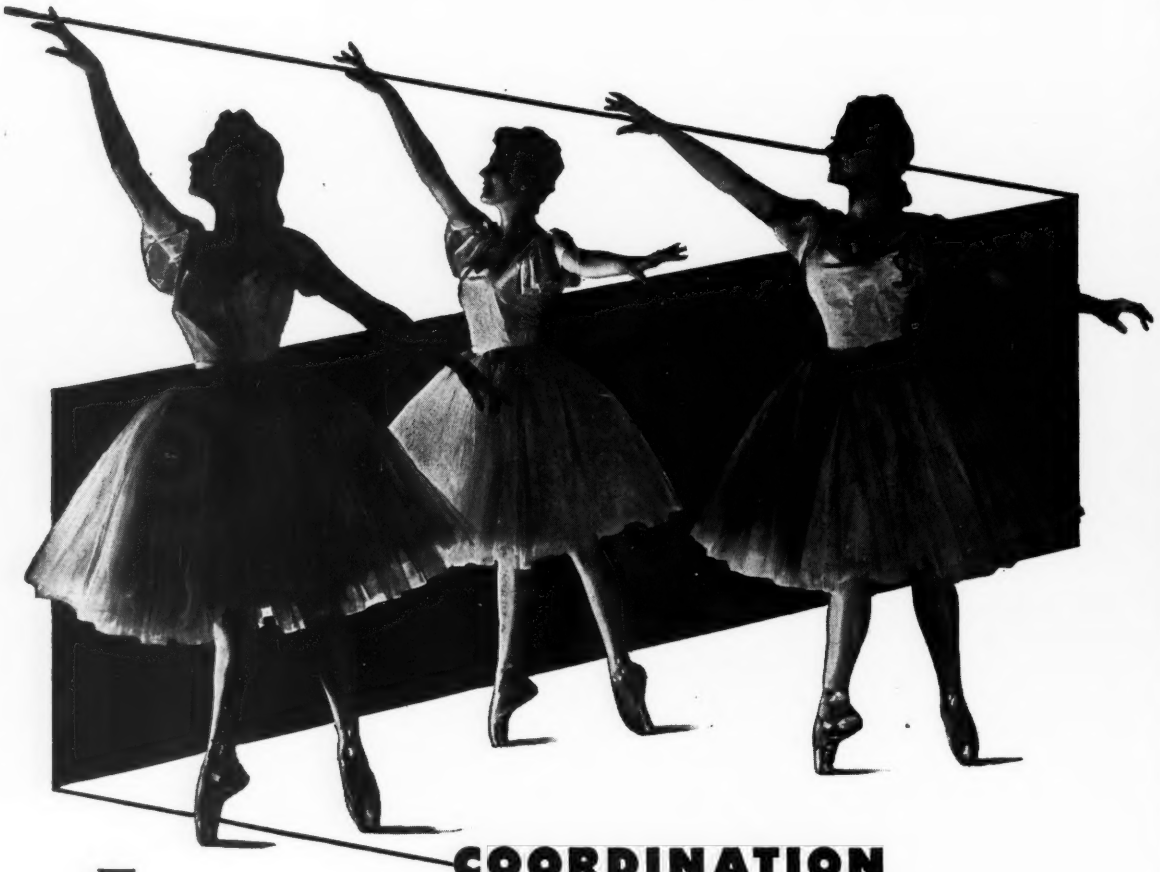
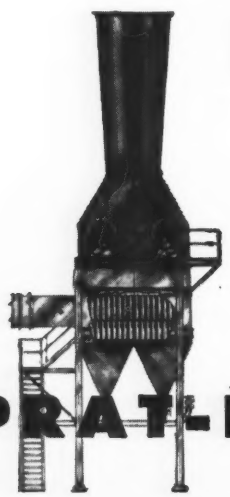


COORDINATION

Prerequisite to Induced Draft Efficiency



Coordination of the components is as important to the efficiency of Induced Draft Equipment as it is to the smooth harmony of a ballet.

Beside the disadvantage of higher cost when installed separately—unit by unit—the non-integrated breeching, I.D. Fan and Stack, in many cases, operate at sub-standard efficiency due to lack of over-all unified engineering.

Prat-Daniel research has evolved an induced draft system that eliminates this problem . . . provides the absolute ultimate in fuel efficiency.

Result—the well-known Thermix Fan Stack! Inlet Breeching, Fan and Stack combined in a single, integrated draft-producing unit that is unbeatable for high level performance.

From boiler outlet to atmosphere, depend on Thermix Fan Stacks to maintain predetermined, constant draft with full efficiency for your boiler.

Our project engineers will be glad to show you the advantages of Thermix equipment. Write for a complete catalog on your company letterhead. *All inquiries should be directed to*

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THE THERMIX CORPORATION

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PRAT-DANIEL CORPORATION

Manufacturers of Thermix Equipment

EAST PORT CHESTER, CONN.

De Laval pump fitted with submerged suction priming system.

THE DE LAVAL SUBMERGED SUCTION PRIMING SYSTEM

As soon as the pump is started the De Laval submerged suction priming system automatically floods the pump to the eye of the impeller.

With the De Laval Priming System the pump cannot be started unprimed. Were the air inleakage too great for the priming system to handle, the pump would automatically be shut down and could not be started again until the fault had been corrected.

The pumping unit can be started or stopped at any time, from a remote control point, if desired.

Ask for Literature

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GP-5

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Repeat Orders Don't Just Happen!

IN THE COMBUSTION FIELD THEY ARE EARNED BY GOOD ENGINEERING

★

EVERY Republic combustion control system is engineered to co-ordinate the operations of all units and to meet the specific requirements of a particular installation. It is this engineering skill and service that has earned for Republic the reputation reflected in the large numbers of repeat orders from many of America's leading utilities and industrial plants.

This engineering service is available to you on request. Republic engineers will gladly co-operate with your own engineers in the solution of any metering or control problems you may have. Ask to have one of our engineers call. There will be no obligation on your part.

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Good Equipment, Correctly Applied!

THAT IS THE BASIS of effective conditioning of boiler feedwater makeup . . .

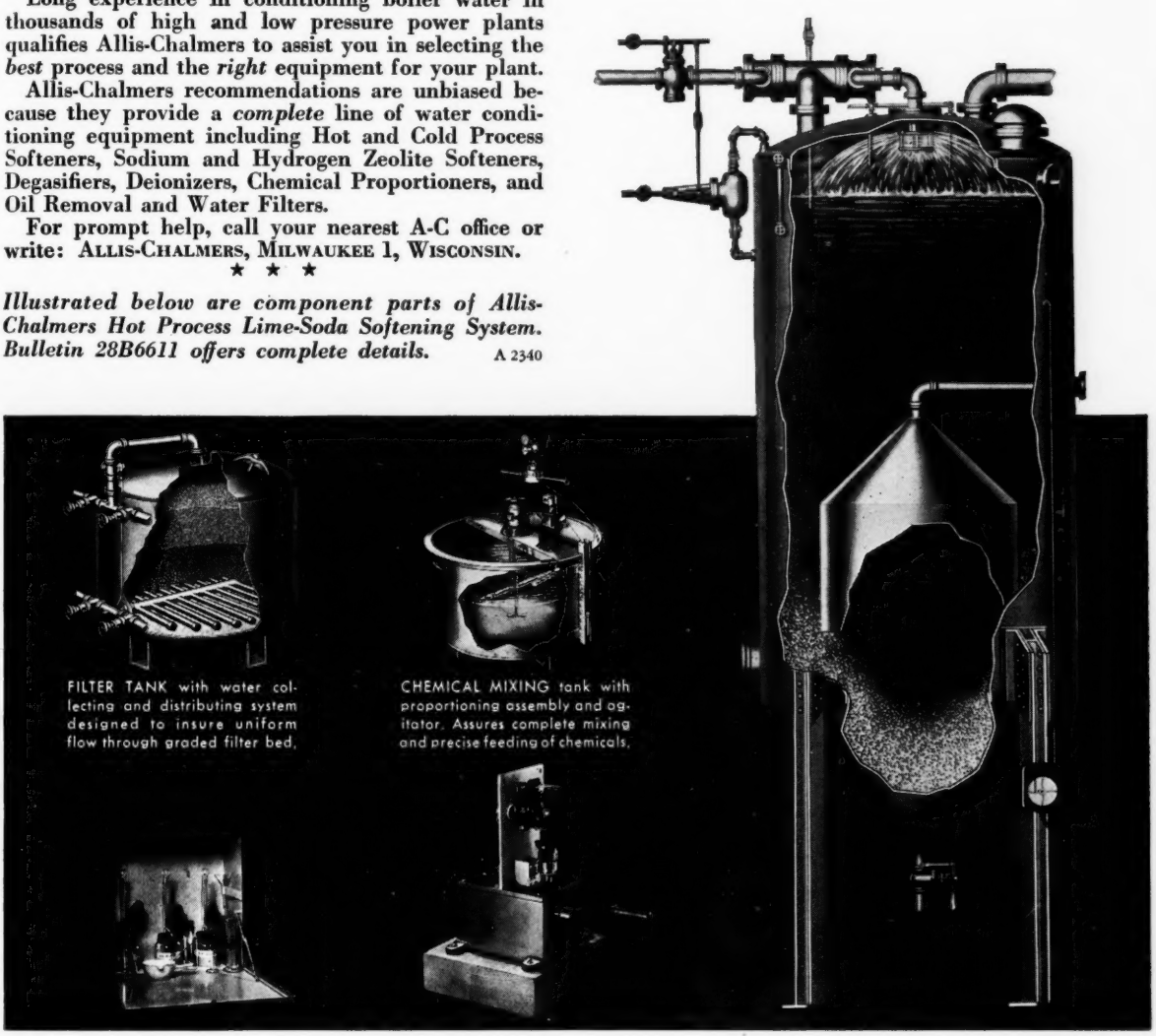
Long experience in conditioning boiler water in thousands of high and low pressure power plants qualifies Allis-Chalmers to assist you in selecting the *best* process and the *right* equipment for your plant.

Allis-Chalmers recommendations are unbiased because they provide a *complete* line of water conditioning equipment including Hot and Cold Process Softeners, Sodium and Hydrogen Zeolite Softeners, Degasifiers, Deionizers, Chemical Proportioners, and Oil Removal and Water Filters.

For prompt help, call your nearest A-C office or write: ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

★ ★ ★

Illustrated below are component parts of Allis-Chalmers Hot Process Lime-Soda Softening System. Bulletin 28B6611 offers complete details. A 2340



FILTER TANK with water collecting and distributing system designed to insure uniform flow through graded filter bed.

CHEMICAL MIXING tank with proportioning assembly and agitator. Assures complete mixing and precise feeding of chemicals.

TEST KIT for treated water analysis and making adjustments in chemical treatment when composition of raw water varies.

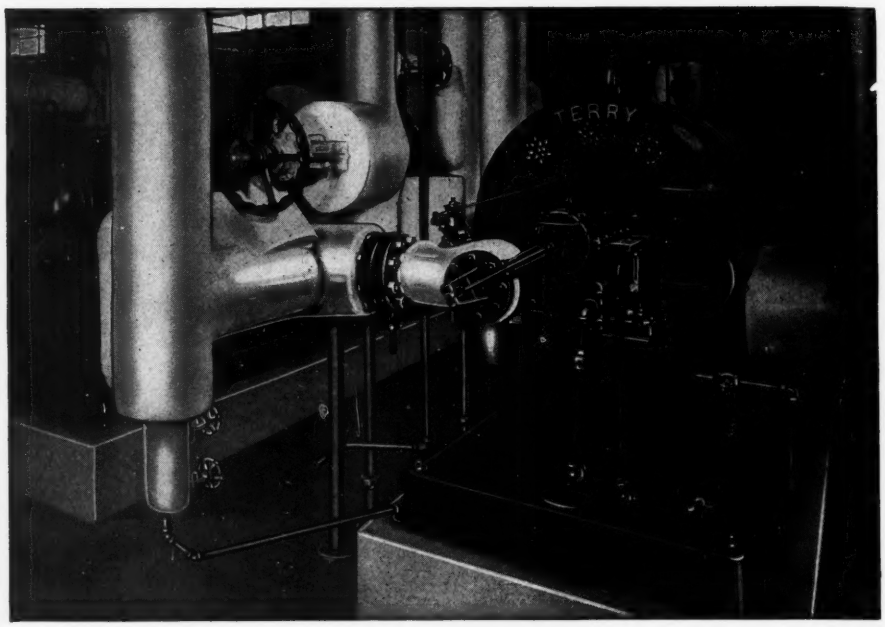
ELECTRO-MAGNETIC proportioner with dust-proof cover removed. Vernier adjustment permits micro-control of chemicals fed.

SOFTENER TANK constructed to provide proper flow velocities for effective chemical reaction and sludge sedimentation.

ALLIS-CHALMERS

One of the Big 3 in Electric Power Equipment—Biggest of All in Range of Industrial Products

TERRY



GENEROUS BLADE CLEARANCES IN THIS 900° TERRY WHEEL TURBINE INCREASE DEPENDABILITY . . . .

The 290 H. P. Terry Turbine shown above is used for Boiler Feed Pump Drive in a recently completed central station. It operates with steam at 850 lbs.-900° F. and employs a Terry one piece wheel, as illustrated at the left.

The blades of this Turbine have large radial and axial clearances. They are further protected by projecting rims at the sides of the wheel. These rims would take without damage any rubbing that might occur if the radial clearance became reduced. It is therefore impossible for the blades to foul.

The side clearance is very large - one inch - so that end play can do no damage.

Such construction makes for dependable operation.
- Descriptive bulletins sent on request. Ask for S-116.

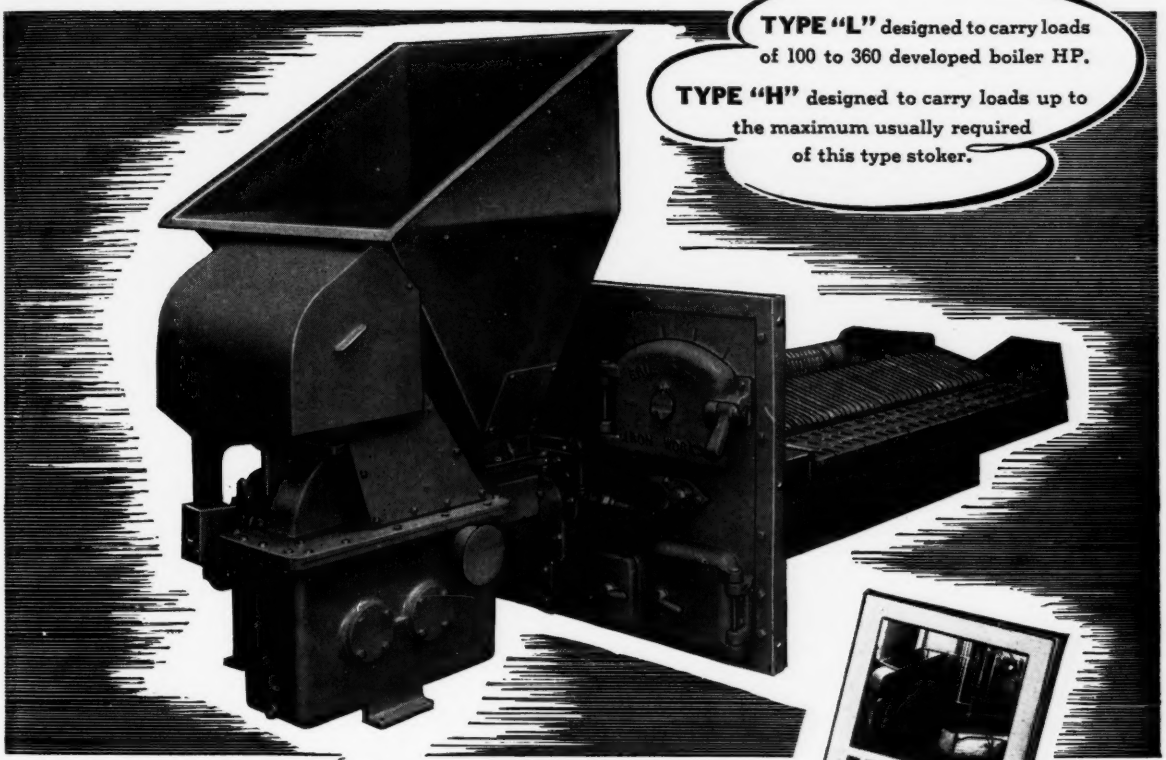
T-1167

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

ERIE CITY *Announces*

AN UNDERFEED SINGLE RETORT RAM TYPE, SIDE DUMP STOKER

Completely developed and built in our own plant, this new Erie City Underfeed Stoker embodies the best in modern stoker design. A special heat resisting alloy iron, product of our own foundry, is used in all castings exposed to the fire. Each stoker is individually fitted and assembled in our shops to assure smooth operation under your boiler. Primarily designed to provide stoker firing for Erie City's 5 Boiler-Furnace Units, Erie City Stokers are available in one of two types for your boiler. Write for complete data.


TYPE "L" designed to carry loads of 100 to 360 developed boiler HP.
TYPE "H" designed to carry loads up to the maximum usually required of this type stoker.

Write for Catalog

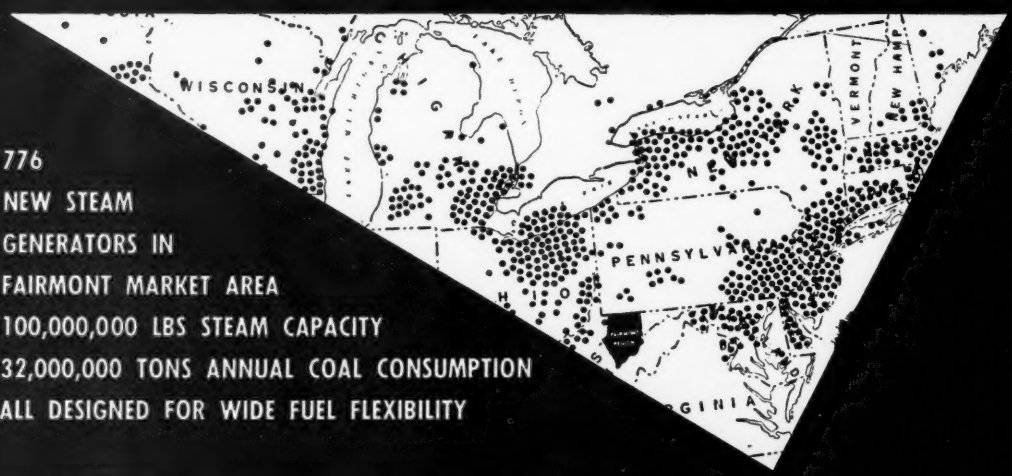
COMPLETE STEAM POWER PLANT EQUIPMENT

ERIE CITY

Complete Steam Generators ● Type C 3-Drum Boilers ● Type VL 2-Drum Boilers ● The "Economic" Boiler with or without Water Walls ● Welded H. R. T. Boilers ● Welded Steel Heating Boilers ● Coal Pulverizers ● Underfeed Stokers ● Welded Pressure Vessels for the Process Industries.

ERIE CITY IRON WORKS • ERIE, PA. • *Since 1840*

THE EXPANDING MARKET FOR FAIRMONT COAL



776
NEW STEAM
GENERATORS IN
FAIRMONT MARKET AREA
100,000,000 LBS STEAM CAPACITY
32,000,000 TONS ANNUAL COAL CONSUMPTION
ALL DESIGNED FOR WIDE FUEL FLEXIBILITY

INHERENT ECONOMY...

Inherent economy is the underlying reason for Fairmont's fast becoming the most favored coal field serving the great industrial triangle whose base lies on the Eastern seaboard between Maine and Virginia and whose apex is in Minnesota. In this vast area is found the greatest industrial concentration in the world. Coincidentally, it is also the greatest coal consuming area.

Strategically located in Northern West Virginia, the Fairmont Field, with its large reserves and excellent rail, river, lake and tidewater transportation facilities, is well appointed to serve industry.

Until recent years, many consumers were unable to take advantage of the economy offered by Fairmont low-ash-fusion coals, because of inadequate fuel-burning equipment. However, today consumers are buying equipment incorporating the latest technological advances in design which assures high thermal efficiency and excellent performance with coals of widely different characteristics.

To meet the unprecedented demand for its economical fuel, the Fairmont Field is engaged in a long-range development program and production capacity is being expanded as rapidly as mining and transportation equipment becomes available.

The Fairmont Coal Bureau is rendering SERVICE TO INDUSTRY through engineering bulletins, fuel studies and cooperation with equipment manufacturers and consulting engineers.

Literature is available describing the technique of "Conservative Design" for steam generators employing various methods of firing.

FAIRMONT COAL BUREAU, Chanin Bldg., 122 E. 42nd St., New York 17, N. Y.

Please send me the Bibliography of technical publications available for distribution by the Bureau ☐. Also include my name on mailing list for future releases ☐.

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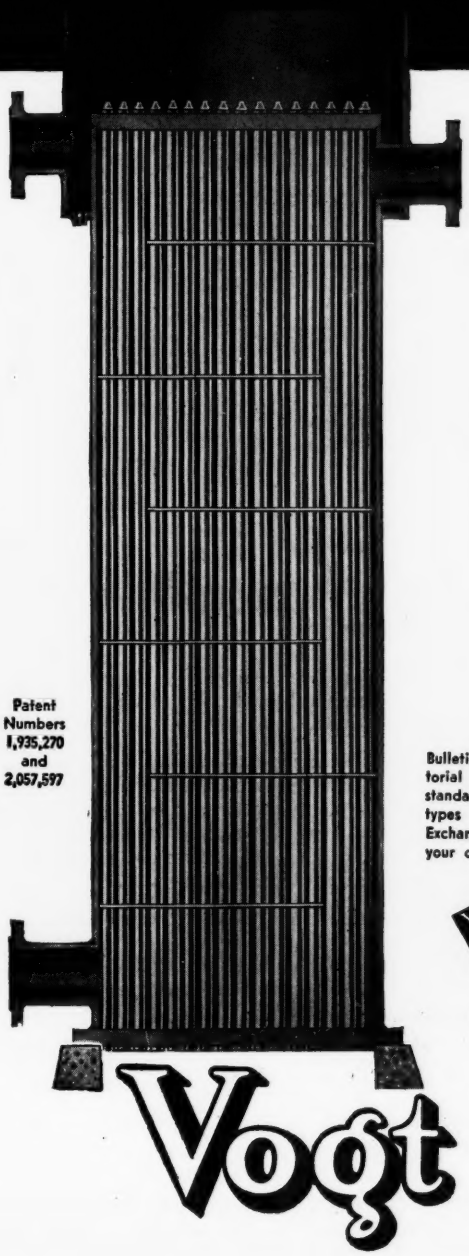
PG-648

FILM TYPE EXCHANGERS

DETAIL SHOWING DISTRIBUTING FERRULE IN TUBE (Patent Pending)



Patent Numbers 1,935,270 and 2,057,597

Vogt engineers have taken a familiar refrigeration plant "old timer" and developed it into this modern, efficient heat exchanger.

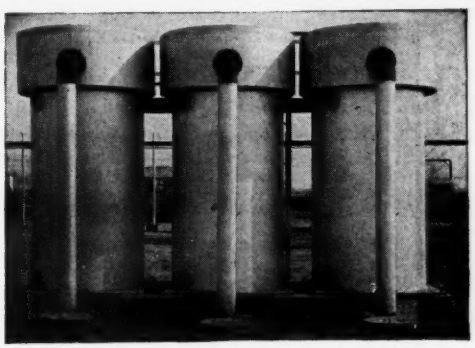
The film type exchanger operates in a vertical position. Water introduced in the top chamber is distributed in a thin film against the inner tube walls by means of special ferrules. The shell side of the exchanger has baffles arranged to provide optimum velocities, pressure drops, and heat transfer rates. Shutdowns are eliminated because tubes can be cleaned while the unit is in operation; thus permitting the use of dirty, mud and silt depositing water.

Vogt Film Type Exchangers now serve as Jacket Water Coolers, Sulphuric Acid Coolers, and Sulphur Dioxide Condensers, and can be designed to condense any vapor. They are also applicable for handling liquids other than water in film flow.

HENRY VOGT MACHINE CO., INC.
LOUISVILLE 10, KENTUCKY

Branch Offices: New York, Philadelphia, Cleveland, Chicago, St. Louis, Dallas

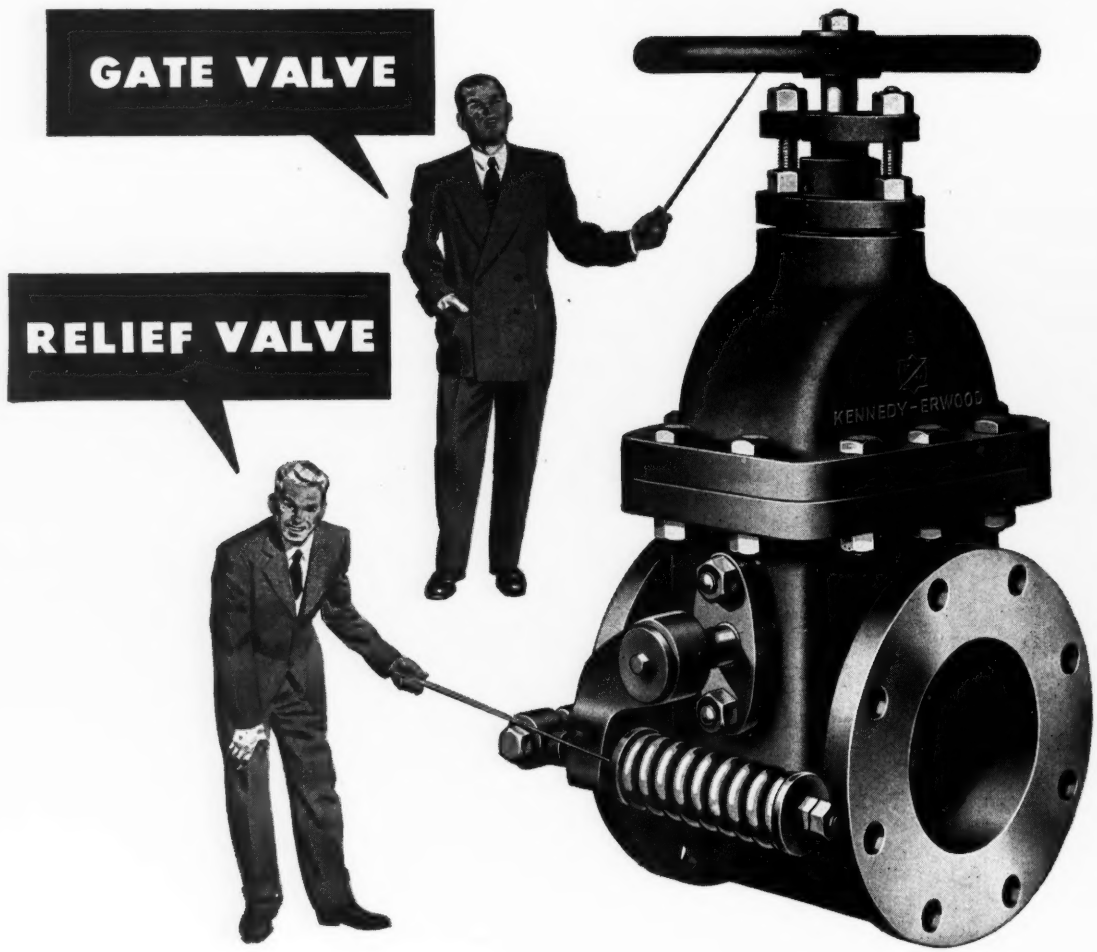
Bulletin HE-5 is a pictorial presentation of standard and special types of Vogt Heat Exchangers. Write for your copy.



Jacket Water Coolers serving engines of 7,300 H.P. Muddy well water used as cooling medium.

Vogt

HEAT TRANSFER EQUIPMENT



Protects Low Pressure Equipment

TYPICAL APPLICATIONS OF THE KENNEDY-ERWOOD VALVE

- *Non-return valve on exhaust lines between steam turbines and condensers. Relief valve on low-pressure stages of turbine casings.*
- *Back-pressure or atmospheric-relief valve on turbines and condenser engines.*
- *Safety gate valve on low-pressure exhaust lines and headers.*

Here is a unique combination valve with important advantages not obtainable in any other design.

For normal operation, the Kennedy-Erwood Valve can be manually opened and closed, just like a standard gate valve. However, if the back pressure exceeds an amount that would be dangerous for the apparatus which the valve is to protect, the predetermined spring pressure permits the disc to open and relieve the pressure. Therefore, it also functions as an automatic relief valve.

Wherever low-pressure apparatus is to be protected from excessive pressure, the Kennedy-Erwood Valve is an essential insurance against the possibility of costly damage. It is widely used for this purpose by central power generating stations and manufacturing and process plants.

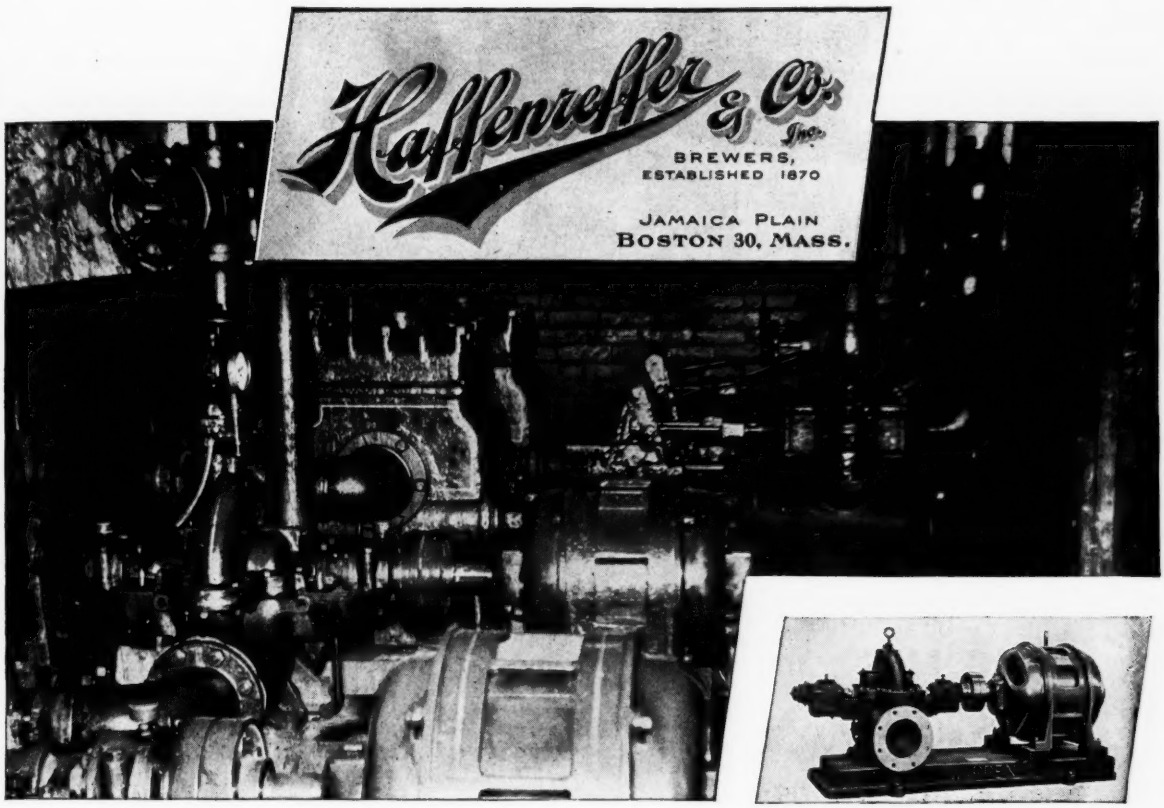
Write for complete information and prices on suitable sizes for your requirements.

THE KENNEDY VALVE MFG. CO., ELMIRA, N. Y.

Offices and Warehouses in Principal Cities

KENNEDY valves-pipe fittings-fire hydrants

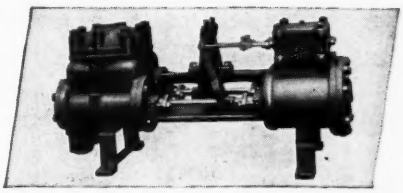
Another famous user of WARREN PUMPS!



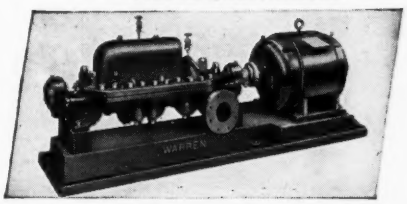
Warren DM and DL, Single Stage, double-suction centrifugal pumps are widely used on various general services. Special metals, capacities, heads, etc., are available to meet various operating conditions.

Haffenreffer and Co., brewers in Boston since 1870, depend on Warren Centrifugal and Reciprocating Pumps for efficient, low-cost, long-life pump performance, just as many breweries and widely varied industries have depended on Warren Pumps for the past half century.

For 50 years Warren engineers have designed and built pumps that have solved the pumping problems of hundreds of plants. If you have a pump problem we invite you to write us, letting us have as much detailed information as possible. Our engineers will be glad to make recommendations, with no obligation on your part.



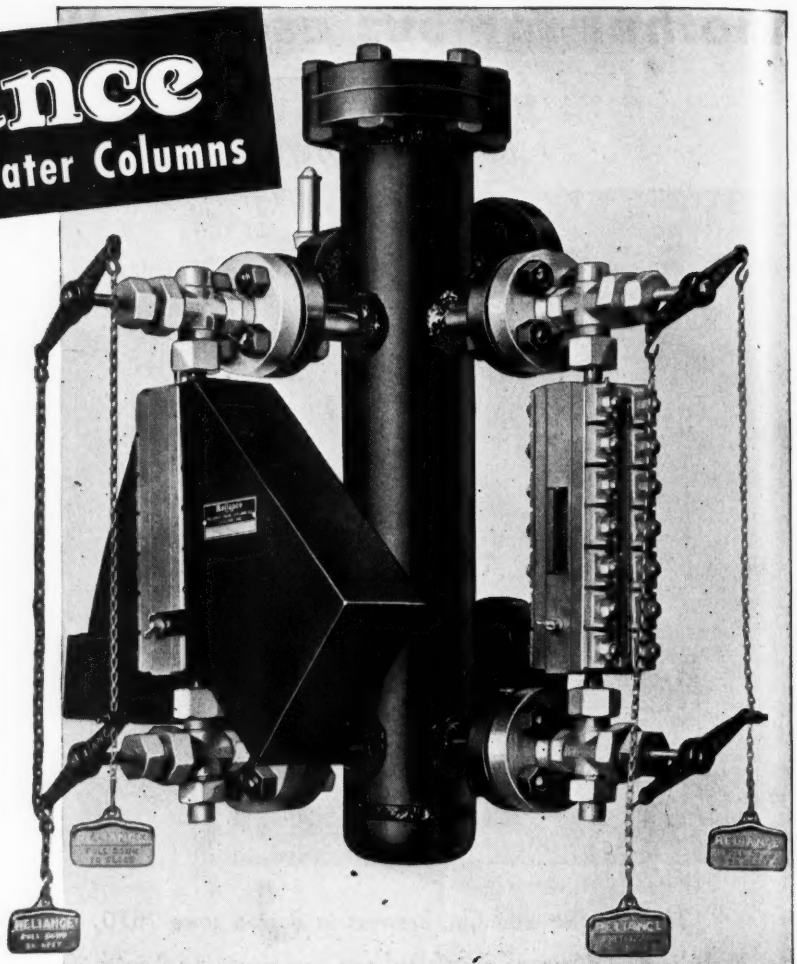
"Realwear" Horizontal Duplex Piston Pumps—a favorite for boiler feed, fuel oil pressure, oil transfer, general water services, etc. Type TM (below) Four and Six Stage for high pressure requirements in boiler feed, etc.
Write for special bulletins



Warren Steam Pump Company, Inc.
WARREN, MASSACHUSETTS P-9

WARREN PUMPS

Reliance
Safety (Alarm) Water Columns



For Dependable Boiler Water Level Supervision

●

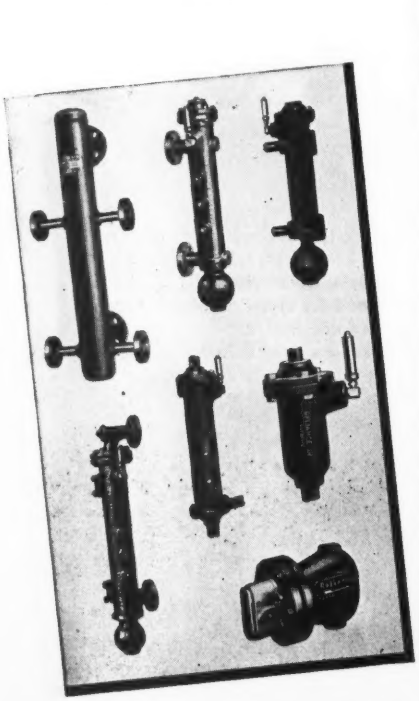
RELIABILITY

SAFETY

LONG LIFE

REASONABLE FIRST COST

LOW UPKEEP



RELIANCE is the pioneer maker of boiler safety devices —was the first to make the ALARM Safety Water Column available to power plants, in 1884. Reliance Water Columns, both with and without alarms, are made in a number of styles and sizes to suit the needs of any type of boiler—any pressure. Those having alarms are equipped with sensitive, positive-acting float-operated alarm mechanisms that have been refined and proved during the nearly 65 years since Reliance introduced the first water columns so equipped.

Reliance Equipment, including complete Water Column "Trim," is approved by national and state code authorities, boiler makers, government bureaus, consulting engineers and operating engineers everywhere.

BOILER SAFETY DEVICES since 1884

Reliance

THE RELIANCE GAUGE COLUMN CO. • 5902 CARNEGIE AVENUE • CLEVELAND 3, OHIO

Chlorination

PUTS THE PROFIT IN THIS EQUATION

The log mean terminal temperature difference goes down and stays that way when chlorination goes to work and stops slime formation on the water-side surfaces of your condensers and heat exchange equipment. This means lower fuel costs, less out-of-service time, the elimination of plug cleaning, more profit.

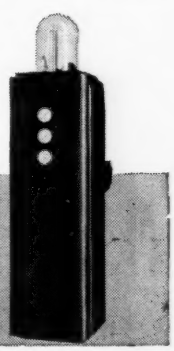
Since even the slightest slime film means a high LMTTD, it is important that the remedy get at the basic cause of the trouble—slime forming organisms. That's just what chlorination does and here are some typical examples of the profitable results:

A southern power station realized a net annual saving in steam costs alone of $16,000 from a W&T installation.

A refinery obtained enough savings through condenser de-sliming by chlorination to pay the cost of the installation in six months.

A midwestern power company obtained savings of $11,000 in one year through cooling water chlorination.

Call your nearest W&T Representative, backed by over thirty years' experience in water treatment, for a cooling water study of your plant—there's no obligation, of course, and you may find, as so many other plants have, that the LMTTD isn't as low as it could be with chlorination.



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The modern Troy-Engberg Steam Engine is designed to extract the power from the steam you produce before it passes, with little loss in heating value, into your heating or processing cycles. The steam engine acts as a reducing valve but it's a reducing valve that generates power or drives equipment and then exhausts most of the heat units into your processing or heating lines.

The modern Troy-Engberg Steam Engine also offers the following advantages — wide speed range, high overload capacity, high starting torque, conservative speed, exceptional dependability. Investigate this drive for your stokers, fans, pumps, compressors and generators.

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(Established 1870)
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TROY-ENGBERG
STEAM ENGINES • GENERATING SETS • GENERATORS

PYRENE RECALLS 500,000 EXTINGUISHERS

IN A frank statement to the American people, the Pyrene Manufacturing Co. has called in more than a half million of its hand fire extinguishers.

An elusive and persistent corrosive in the extinguisher fluid—supplied to Pyrene by an outside manufacturer—has severly damaged some of the recalled extinguishers and would probably affect others in time, the company explained. The corrosive agent has finally been discovered and the trouble remedied. All extinguishers recalled are of the vaporizing liquid pump type. They are quart and 1½ qt sizes, with the exception of a small number of pint size.

George H. Boucher, Pyrene vice president, promised owners of recalled extinguishers that they would be replaced as soon as possible, but pleaded for patience as the company could not make all replacements at once. Boucher said the recalled extinguishers were mostly in industry and commerce and that probably only from 15,000 to 25,000 were in private homes.

The extinguishers Pyrene is trying to retrieve carried Underwriters' Laboratories' numbers on their metal labels included in the following groups.

1½-QUART EXTINGUISHERS

150781	to	150900	461331	to	478330
235486	to	235530	480481	to	494480
236731	to	237230	497631	to	504630
403106	to	404730	505631	to	509630
411998	to	414430	510256	to	518255
416631	to	419830	520356	to	520955
419931	to	449230	532356	to	533748
449631	to	458930	539856	to	544312
460931	to	461230			

1-QUART EXTINGUISHERS

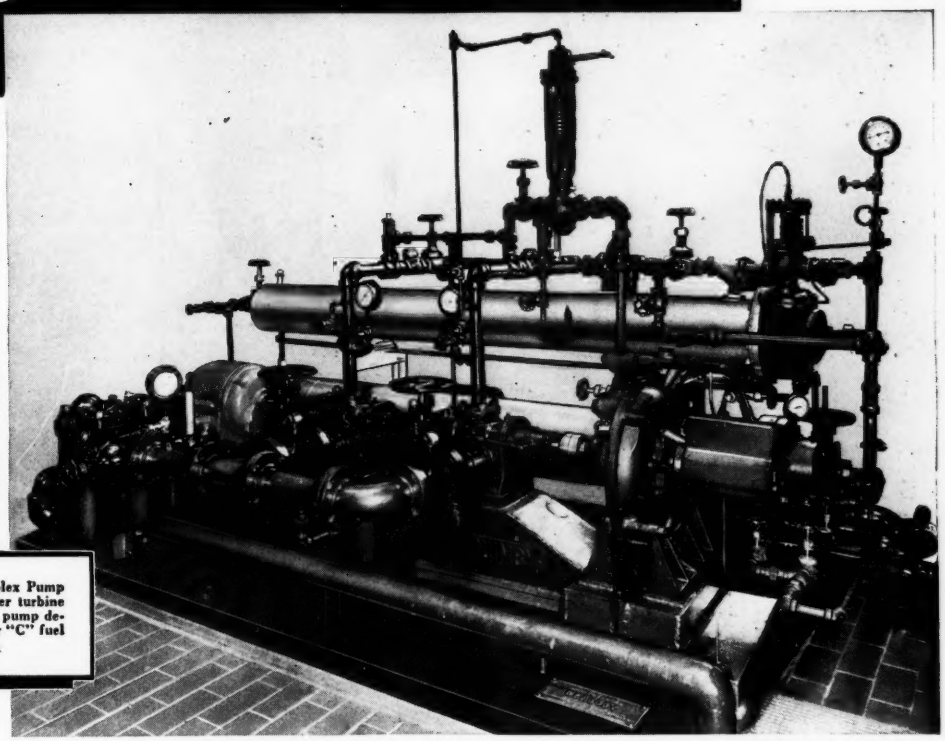
R689558	to	R689997	T793151	to	T843750
R692644	to	R693497	T844550	to	T845050
R731288	to	R732363	T846551	to	T853350
R751698	to	R753697	T854051	to	T854700
T334485	to	T380550	T861051	to	T906880
T398671	to	T485550	T911051	to	T976216
T583051	to	T585050	T977051	to	T999999
T585551	to	T601200	U2	to	U27050
T601801	to	T676150	U33051	to	U33990
T676251	to	T680483	U37651	to	U38784
T680651	to	T711650	U64651	to	U79650
T712151	to	T792150	U80151	to	U100150
			U150151	to	U152552

However, some extinguishers listed above were rebuilt recently and should not be returned. They are stamped around the outlet nozzle with the symbols A-48, B-48, etc. to L-48 or the letter X.

Boucher asked owners to examine their extinguishers closely and, if they are in the affected groups and not among the exceptions, to return them to the place of purchase or to the Pyrene Manufacturing Co., Department RX, No. 10 Empire Street, Newark 5, New Jersey. Since there are no identifying serial numbers on Pyrene 1-pint extinguishers, Boucher requested that these be returned to the same address for testing and replacement if necessary.

Also, all Pyrene Fire Extinguisher Liquid (Refills) purchased from any source prior to January 1, 1948 should be returned for replacement. But the refills should be shipped on a separate bill of lading to another address—Pyrene Manufacturing Co., 560 Belmont Ave., Newark 8, N. J.

DEPENDABLE, EFFICIENT and *Designed* FOR YOUR PLANT!



Typical Peabody Duplex Pump and Heater Set. Either turbine or motor driven screw pump delivers 12 GPM Bunker "C" fuel at 250 lbs. and 220°F.

. . . the completely automatic PEABODY FUEL OIL PUMP and HEATER SETS

Peabody Pump and Heater Sets, designed to burn Bunker "C" or other heavy fuels, are the result of more than 25 years of research and engineering in oil combustion efficiency. Compact, complete and built to last, Peabody units are always specified when plant overhead must be minimized and modernized to meet today's rising costs. Available in a wide capacity range, *for all types of burners.*

Here are only a few advantages you get in a Peabody installation:

Each set designed to specific requirements • Compact, complete unit mounted on common base • Quick, easy installation • Clean fuel delivered to burners at proper temperature and pressure • All parts available for inspection and maintenance • Easily cleaned, with no "down time" • Minimum space required • Factory-built and tested, delivered ready to receive your plant service connections • Low-mounted pumps, minimum suction lift

Complete details on request. Write for Bulletin 150.

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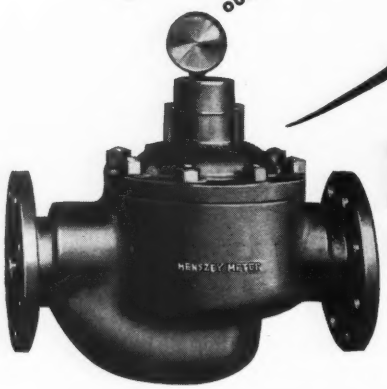
ACCURACY ASSURED!

✓ Built-in Accuracy
Rugged construction without close clearances.

✓ Easy to Check
Easily tested right on the job without costly apparatus.



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FEED WATER METERS

Continuous Blowdown • Distillation Systems • Heat Exchangers
Boiler Feed Regulators • Flow Indicators • Proportioning Valves
also MILK EVAPORATORS and PRE-HEATERS

COMING EVENTS

NSSC—The Annual Meeting of the National Specialty Club will be held at The Homestead, Hot Springs, Virginia, June 10, 11 and 12.

SMA—The Annual Meeting of the Stoker Manufacturers' Association to be held at the Greenbrier Hotel, White Springs, W. Virginia, June 17, 18 and 19.

ASCE—1948 Summer Convention of the American Society of Civil Engineers to be held in the Olympia Hotel, Seattle July 21 and 22.

ASTM—The Annual Meeting of the American Society for Testing Materials to be held in Detroit. Headquarters at the Book-Cadillac Hotel, June 21 to 25.

Instruments — Instrument Society of America annual meeting to be held in Convention Hall, Philadelphia, September 13 to 17.

ACS—Fifth National Chemical Exposition of the American Chemical Society to be held at the Chicago Coliseum, Chicago, October 12 through 16.

ASCE—1948 Fall Meeting of the American Society of Civil Engineers to be held in the Statler Hotel, Boston, October 13-15.

Power Show—18th National Exposition of Power and Mechanical Engineering will be held in Grand Central Palace, New York, November 29 to December 4.

AIEE—Meetings of the American Institute of Electrical Engineers to be held in 1948 are: Summer General Meeting, Mexico City, Mex., June 21-25. Pacific General Meeting, Spokane, Wash., Aug. 24-27. Middle Eastern District Meeting, Washington, D. C., Oct. 5-7 Midwest General Meeting, Milwaukee, Wis., Oct. 18-22. Southern District Meeting, Birmingham, Ala., Nov. 3-5. No headquarters announced yet.

NEW ENGINEERING BOOKS

Freehand Sketching for Engineers, by William Wirt Turner; 34 pages, plus 45 work sheets, illustrated; 8½ by 11 in., paper binding, published by The Ronald Press Co., 15 E. 26th Street, New York 10, N. Y.; price $3.00.

Simplified Perspective, Its Theory and Practical Application, by William Wirt Turner; 235 pages, illustrated; 6 by 9 in., cloth binding, published by The Ronald Press Co., 15 E. 26th Street, New York 10, N. Y.; price $5.00.

The first of these books, on Freehand Sketching, should be particularly valuable to practicing engineers and engineering students, for they must be able to make good freehand sketches, graphically presenting facts and relationships that cannot be put into words. To many engineers, proficiency in freehand sketching is of more service than the ability to make good finished drawings.

Practice in sketching, if properly founded on an intimate acquaintance with the principles underlying the theory of projection, will be time well spent. The term "freehand sketch" is often misinterpreted. It is not a careless, haphazard, crude and inaccurate representation of an object. A freehand working sketch is in reality a working drawing. It must be accurate, must contain all necessary information for the construction of the object; or, if a finished instrumental drawing is to be made from it, the sketch must be the silent spokesman to the draftsman.

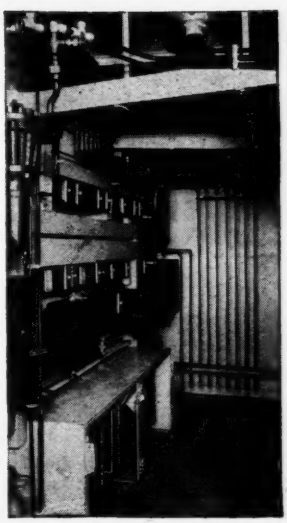
To show engineers how this should be done properly, the author, professor and head of the Department of Engineering Drawing at the University of Notre Dame, gives working instructions for individual work sheets, telling what the problem is, defining terms and giving comments on the various problems.

Complete detailed instructions for freehand sketching procedure from actual equipment are given, such as making measurements, determining proportions, methods of drawing circles and elipses, and the like.

The author's second book is a very detailed discussion of perspective, but explains it quite simply, with the aid of many diagrams, projection drawings and detailed instructions. While it deals more with the principles of perspective used in architecture, the guiding principles are stated repeatedly and amply illustrated, and the style is descriptive rather than technical. For those reasons, it will give

Front view of control cubicle as assembled in our plant before shipment to an electric power company.

Interior views of the above cubicle, showing compact, accessible, modern arrangement.



A complete "package" of L&N control boards or cubicles for boilers and turbines is a true economy, for power-plant designers, constructors and operating engineers.

Our engineering service includes panel layout as well as complete detailing of steelwork, with final wiring and piping diagrams. All this work, done efficiently by specialists in our engineering department, minimizes the user's engineering effort.

The L&N Board normally reaches the user with all controllers, instruments and accessories in place. Every connection for every item is installed at our plant, and tagged. The entire cubicle is ready for connection to L&N Drive Units and to all other external components. It will give sensitive, accurate automatic control and dependable information, for operation at highest efficiency. If you're planning for a new steam-generator, let us tell you the L&N story either personally or by catalog.

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The two seats in each Dart Union are spherical-ground to form a *true ball joint* that's drop-tight and leak-proof.

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much help to anybody in either engineering or architecture who must make perspective drawings.

Elementary Thermodynamics by Virgil Moring Faires; Revised Edition; 268 pages, size 6¼ by 9½ in.; illustrated; cloth; published by The Macmillan Co., New York, 1948; price $4.40.

This book, which first made its appearance in 1938, presents the textual material for a short course in thermodynamics. The book differs from the more complete texts in thermodynamics only in that it presents fewer topics for consideration, not in that it presents shortened discussions. The material in this book is complete for the topics offered. The author felt that completeness in treatment of the topics should not be sacrificed in order to include a wide range of material that would be appropriate for a course designed to be full in scope.

While the book is essentially a textbook to be used in colleges it should be of considerable value to the engineer practicing in the field as a refresher. The book is unusually well written. Care has been exercised to use technical words in their precise meaning. This revised edition has been brought up-to-date by inclusion of a small number of changes, in particular a discussion of the theory of the gas turbine. The book is also complete in that at least it shows a diagram of an atomic power plant. The author is Professor of Mechanical Engineering at the Agricultural and Mechanical College of Texas.

Engine Room Questions and Answers, by Alex Higgins; first edition; 154 pages, illustrated; size 8½ by 11 in., cloth binding; published by the McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y.; price $4.00.

Here is a good companion volume to the author's recent book Boiler Room Questions and Answers.

The book has been written along the same lines as the Boiler Room Questions and Answers Book and with the same object in view. That is to provide a study guide on engine room operation for men preparing to qualify themselves for certificates or licenses as operating engineers. It is also used for reference in the solution of power plant operating problems.

The questions deal with the points of engine room design, construction and operation of most importance to the power plant operator and therefore most frequently encountered in examinations for the various grades of operating certificates. The illustrations are detailed, clear and large enough to show construction of the equipment.

The various questions and answers are covered under the following chapter divisions: Parts of the Steam Engine; Principle of the Steam Engine; The Steam-engine Indicator; Indicator Diagrams and Indicated Horsepower; the Simple Slide Valve; Special Forms of Slide Valves; Valve Diagrams; Reversing Valve Gears; Flywheels and Governors; Corliss Engines; Four-valve, Uniflow and Rotary Engines; Compound Engines; Condensers; Steam Turbines; Steam-turbine Details; Steam-turbine Details of Construction and Operation; Friction and Lubrication; Bearings and Their Lubrication.

Heating and Ventilating's Engineering Databook by Clifford Strock; 576 pages; illustrated; size 8½ by 11 in., cloth bound; published by The Industrial Press, 148 Lafayette St., New York 13, N. Y.; price $7.00 postpaid.

This book has an 8½ by 11 in. page size, permitting use of large, easy-to-read type in the tables and text, and clear, accurate interpretation of large-scale graphs and charts.

The data are organized into ten sections —Heat and Moisture in Air, Fuels and Combustion, Piping, Air Handling and Ventilation, Heating and Heat Transmission, Cooling and Air Conditioning, Motors and Drives, Contract Law, Mathematical Data and Drafting Room Practice, and Terminology.

Purely practical in character, the Engineering Databook is intended for everyday use by heating, ventilating, and air conditioning engineers, contractors, architects, plant engineers, and engineering students. Emphasis is placed on the data needed in actual design with only sufficient text to explain the use of the data.

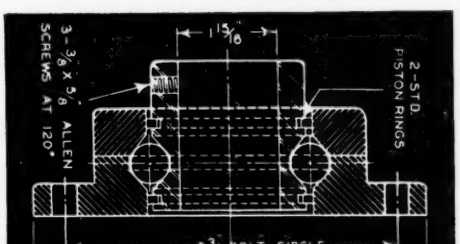
The Databook is up-to-minute as possible and includes information on the Heat Pump, Electrothermal Storage, Snow Melting, Heating with Diesel Engines, Solar Water Heating, and Radiant (Panel) Heating.

A most useful and unusual feature of the Engineering Databook is the section devoted to the law of contracts. This section is based on actual higher court de-

DETAILS LIKE THIS MAKE HEACON A BETTER DAMPER . . .

Heacon dust-proof bearings

. . . sealed, free turning bearings, for applications operating in dust filled atmosphere



This drawing shows the simple construction of the Heacon bearing. Ample clearance is provided to accommodate expansion due to heat and misalignment. Metal ring seals on either side of ball races provide proven guard against dust leakage, yet permit free rotation.

One of the advantages of Heacon Dampers is that of low power, constant torque for operating the curtain shaft.

Heacon designed dust-proof bearings are largely responsible for the easy rotation of this spindle—they will also operate freely even if shaft is out of alignment. The inherent design of the damper relieves the operating shaft of strain due to gas flow or static pressure.

This dust-proof bearing is only one of many details in the design of a Heacon Damper that assures you satisfactory performance with a minimum maintenance for practically the lifetime of your equipment.

Heacon dust-proof bearings are available for other applications involving shaft operation in a dust concentrated atmosphere. For information write the project engineer nearest you.

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No other cleaner could do it!

★ The engineer of an upstate New York university power plant with five large boilers tried every known make of tube cleaner, including our old Roto. He didn't think any of them "worth a hoot" for removing his rock-like scale.

★ When we developed the new ROTOJET, we sent him our Model 525 for field test. He was so amazed and tickled with the way this powerful new cleaner performed that he insisted on buying it. He said it was the first cleaner that ever cleaned his tubes properly, and that "it made a tough job seem ridiculously easy."

★ No tube cleaner built during our 38 years of specialization in this field can even remotely compare with the new ROTOJET for power, efficiency, and cleaning speed. A single cleaning job with a ROTOJET will prove that you can't afford to use any other tube cleaner.

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cisions which apply specifically to heating, ventilating and air conditioning cases. In this section are discussed: the validity of contracts, implied warranty, technical competence, alteration of plans, extras, subcontracting, substitutions, inconspicuous clauses, guarantees, distinction between employee and contractor, and many other points covered in the law of contracts. Each case used as an example is one in which a heating, ventilating or air conditioning contractor or engineer was involved. In addition, other legal subjects which concern heating men are discussed, such as; patent infringement, real estate law, relations with municipalities, mechanic's liens, withdrawals of bids, and "cost plus" contracts

Henley's Twentieth Century Book of Formulas, Processes, and Trade Secrets; 1945 Revised Edition; Edited by Gardner D. Hiscox and new revised and enlarged edition by Prof. T. O'Conor Sloane; 867 pages, size 5 by 8 in.; published by The Norman W. Henley Publishing Co., 17-19 West 45th St., New York City; price $4.00

Here is the latest edition of a book that has been a standard reference for the home factory, office, laboratory and workshop for many years.

The new revised edition includes a complete ready-reference index. This book has always contained a great deal of useful information difficult to find in many other works. In it you will find, for example, a discussion of cotton seed hulls as stock feed, followed immediately by a method for detecting counterfeit coins, and a formula for making liquid court plasters.

There is, for example, a long, detailed discussion of exactly how to carry out commercial enameling using a small enameled sign as a typical example. Recipes and formulas for extracts are followed by detailed instructions for etching. Instructions are given for making all kinds of beverages, particularly wines and beer.

If you want to learn how to lay galvanized iron roofing, here are detailed instructions. The book tells you how to dissolve iodine, how to make a good preservative for leather, how to color metals, how to make photographic solutions on pigments recipes for many different kinds of soap are included, also much practical and useful information on such things as vanilla varnishes, wax, wines and liquors, bleaching materials, and so on.

A buyer's guide and a chapter on various materials and chemicals are included also a chapter on useful workshop and laboratory methods.

Principles of Jet Propulsion and Gas Turbines, by M. J. Zucrow; first edition, 1948. 563 pages, illustrated; size 6 by 9 in., cloth binding; published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16, N. Y.; price $16.50.

The author is Professor of Gas Turbines and Jet Propulsion at Purdue University, from which he has received his Ph. D. degree. He has had wide experience in industry, particularly in certain commercial companies dealing with flow of fluids, development of gas turbines and other equipment for jet propulsion, has designed and developed carburetion equipment for burning heavy fuels, power plant instruments and other industrial engineering devices.

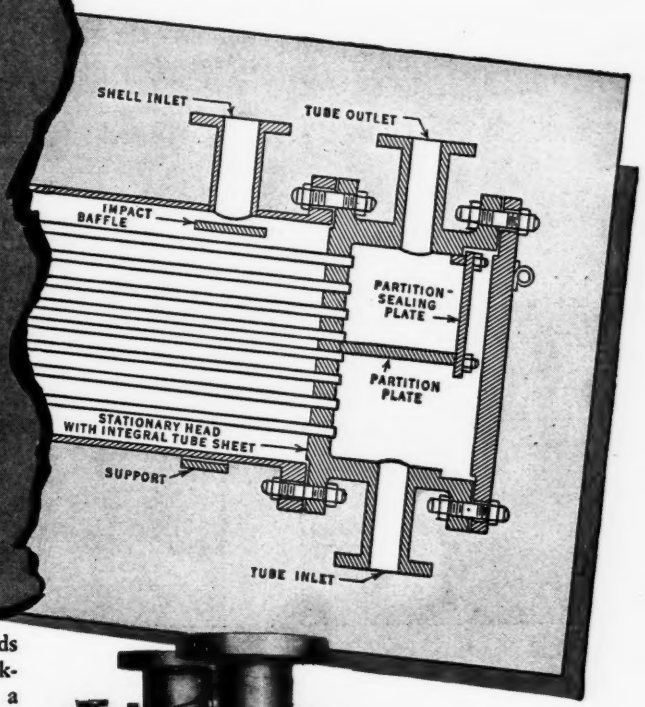
It is from this background that he has written this book, which is based on a course he gave to graduate aircraft engineers during the war.

The book treats of basic principles and because it was written during the war, certain material could not be included in it.

After an introductory chapter reviewing the fundamental principles of jet propulsion, the author discusses momentum and energy relationships for fluids, thermodynamics of gas flow, thermodynamic properties of air, airplane performance calculations, the airplane propellor, the gas turbine power plant and its components, and the rocket motor. The book concludes with a chapter on some aspects of high-temperature metallurgy. The reader is required to have considerable knowledge of algebra and some knowledge of the calculus to comprehend the discussion properly. The book is well illustrated with diagrams, charts and tables and an index is provided.

A FUEL OIL additive, which has the ability to take gums, sludges, and asphaltic heavy ends into solution, pass them along into the burner with the oil and burn them, rather than have them deposited in tanks, lines and nozzles, has been developed by E. F. Houghton & Co.

Leakage Between Passes Prevented in G-R FEEDWATER HEATER



The partitions between passes in the water heads of feedwater heaters are a fruitful source of leakage that can't be detected. The head cover is a literal "iron curtain" behind which you can't see short-circuiting of water between passes.

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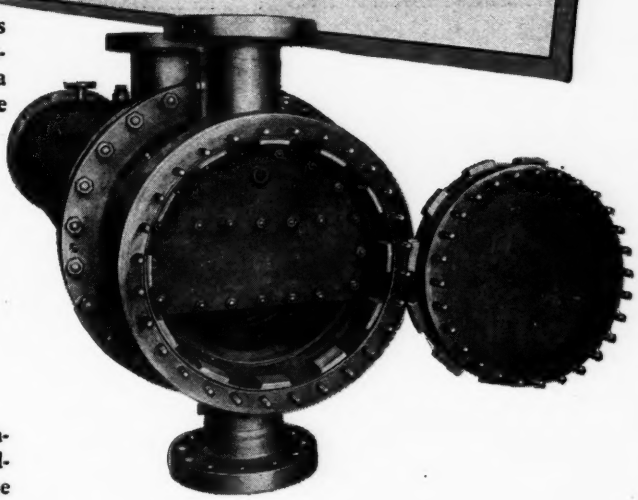
●

The sketches tell the story. It's one of many instances of G-R pioneering in the design of feedwater heaters. Write for bulletin describing these heaters and their many distinctive features that give you benefits you can't obtain in other feedwater heater designs.



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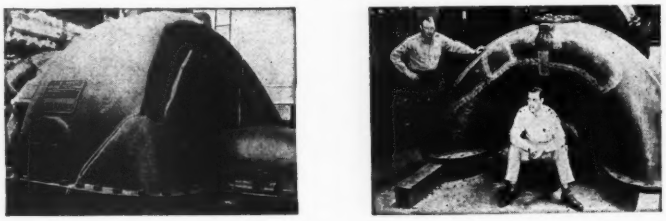
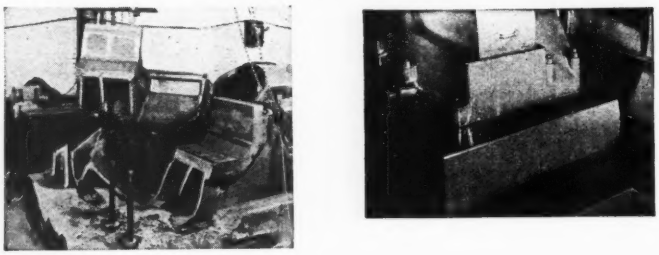
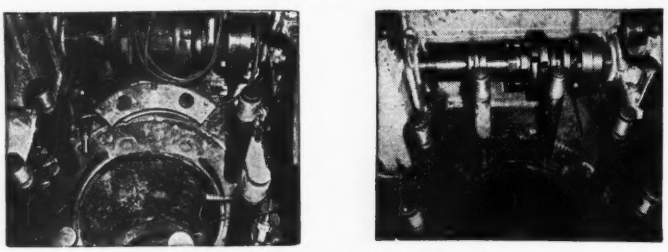
Before **10,000 KW. STEAM TURBINE** **After**



Before **LARGE COMPRESSOR FRAME** **After**



Before **32 IN. DIA. DIESEL ENGINE BLOCK** **After**



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SOUTHERN ADVANCE

(Continued from page 54)

former equipped with a 250-hp Terry single-stage unit, the latter a 170-hp Terry single-stage unit. Both turbines operate at 430 psi and exhaust into the 35-psi header. The forced-and induced-draft fans on boiler No. 8 are motor-driven.

The boiler feed equipment consists of: two 3-stage high-pressure turbine-driven Allis-Chalmers pumps rated at 900 gpm, one 4-stage high-pressure turbine-driven Allis-Chalmers pump rated at 600 gpm, and one 5-stage high-pressure turbine-driven Warren boiler feed pump rated at 500 gpm, which is used as a standby. The high-pressure pumps supply boiler feedwater for both the main power plant and the recovery boilers. Boiler feed equipment for the low-pressure bark-burners consists of one 2-stage Warren pump and one 3-stage Worthington pump. Both are low-pressure pumps and are motor-driven.

HEAT CYCLES

(Continued from page 58)

and for process steam pressure, is required. A single interpolation on the left hand side of the chart, for process steam pressure, is required. The result obtained in this case is 63.3 per cent.

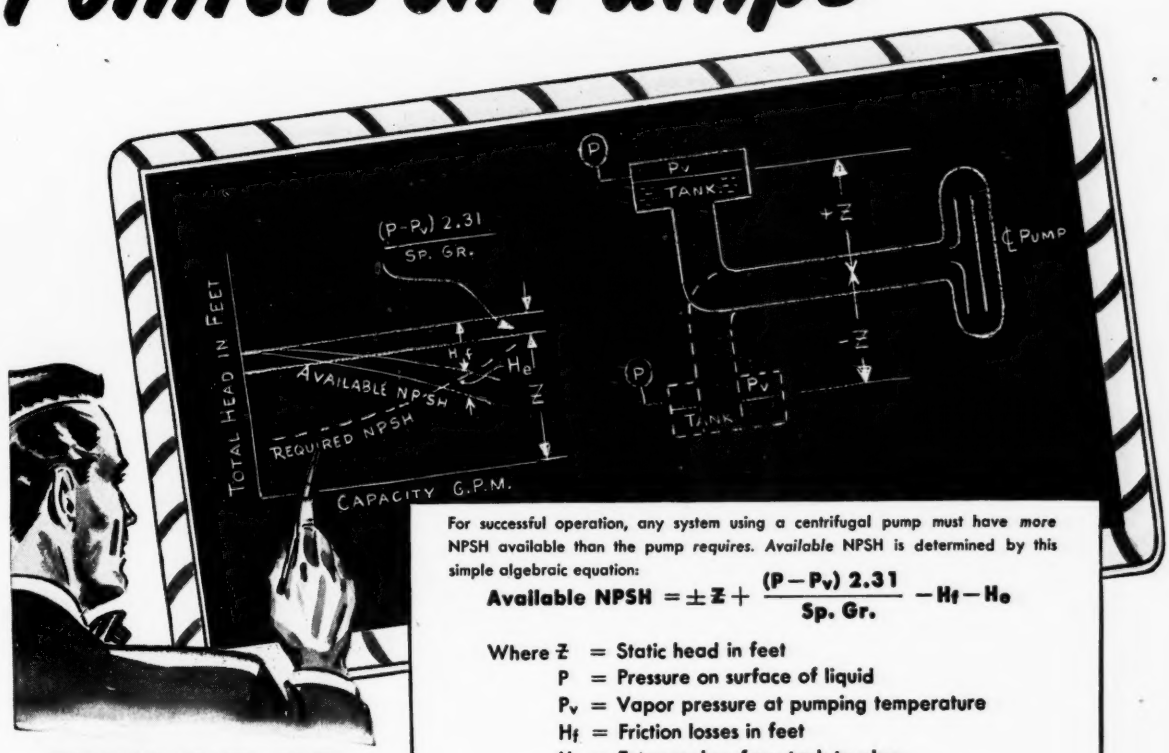
For values of pounds of process steam per hour per kw below 10, the curves may be extended to the left for any desired value down to zero. The procedure is then the same as in the previous examples except that on the right hand side of the chart it is necessary to move to the right to intersect the vertical reference line between the right and center portions of the chart.

An inspection of the high pressure side of Figs. 5 and 6 shows that the advantage of 600 psig, 750 F over 400 psig, 750 F is not uniform. In general this advantage increases with kw load, with process steam pressure and with pounds of process steam per kw load.

The charts do not and are not intended to cover all the conditions that may be encountered in an industrial power plant but it is expected that their use will, in the majority of cases, indicate possible saving and serve as a guide in the selection of suitable conditions.

A NEW PAINT brush has been developed which will hold considerably more paint than was formerly possible. It makes use of hollow plastic bristles whereby the paint will not only be held by capillary action between the bristles, but also in the hollow centers of the bristles.

Pointers on Pumps



For successful operation, any system using a centrifugal pump must have *more* NPSH available than the pump *requires*. *Available* NPSH is determined by this simple algebraic equation:

$$\text{Available NPSH} = \pm Z + \frac{(P - P_v)\ 2.31}{\text{Sp. Gr.}} - H_f - H_e$$

Where Z = Static head in feet
P = Pressure on surface of liquid
P_v = Vapor pressure at pumping temperature
H_f = Friction losses in feet
H_e = Entrance loss from tank to pipe

NOTE: For boiling liquids, P usually equals P_v; this item is therefore omitted from the problem.

WHAT IS NPSH?

NPSH (net positive suction head) is an ***absolute*** term covering hydraulic conditions at the suction side of a centrifugal pump. It can be used instead of the ***relative*** terms "suction lift" and "suction head" to assure the proper application of centrifugal pumps. These relative terms are useful in calculating the total head against which the pump must operate; but they should not be used when considering the suction condition as it affects proper centrifugal pump selection.

Actually, every centrifugal pump has its own NPSH characteristic, usually referred to as "required NPSH" The pump impeller opening must be filled at the required rate of flow (GPM) so the impeller can pump at this rate. The velocity needed to put this quantity into the impeller opening must come from an external head. The value of this external head is the "required NPSH".

Obviously, if the liquid pumped is not to vaporize in the entrance to the impeller, the required NPSH must be measured over and above the vapor pressure of the liquid at the pumping temperature. The required NPSH will vary roughly as the square of the pump capacity through the useful range of application of that pump.

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Worthington has the most complete line of centrifugal pumps — all pressures, all capacities — and engineers ready to give you expert advice on any pumping problem. For further details proving *there's more worth in Worthington,* contact our nearest District Office, or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

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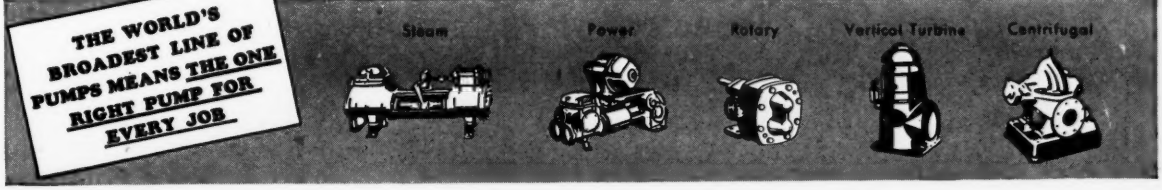

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WILSON TUBE CLEANERS

TRENDS IN MODERN FEEDWATER CONDITIONING EQUIPMENT

(Continued from page 61)

solved gases such as oxygen and carbon dioxide in the feedwater. If the boiler pressure is under 250 psi and there is no steel tube economizer present, the amount of dissolved oxygen that may be tolerated is 0.1 to 0.2 ml/l. Open spray heaters, spraying water once through a steam space, will remove over 95 per cent of the dissolved gases, producing an effluent that would meet this specification. With higher boile pressures, or with steel tube economizers present that are sensitive to the slightest amount of dissolved oxygen, complete deaeration should be practiced. Dissolved oxygen of 0 to 0.00ɔ ml/l can be obtained with proper spray type deaerators in which after the initial spraying as in the open heater, the preheated water is reboiled or scrubbed by a large excess of the pure gas-free steam that flows counter current to the water.

In addition, sodium sulfite should be added to the boiler so that an excess of 30 to 40 ppm of sodium sulfite is maintained in the saline to act as a chemical barrier against the slippage of any oxygen into the boiler.

Carbon dioxide, which forms corbonic acid, lowers the pH value of the water and accelerates the corrosion. Properly designed deaerators remove such carbon dioxide completely at the same time as they remove the oxygen. In fact, some of the bicarbonates present are decomposed into carbonates; producing a pH value of over 8.3 in the feedwater.

Corrosion of condensate return lines must also be guarded against. This is caused principally by the presence of carbon dioxide in the steam from the boiler which dissolves in the condensate formed when the steam condenses.

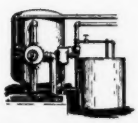
The low pH value which results from this carbon dioxide has caused severe return line corrosion. This is aggravated, of course, if any dissolved oxygen leaks into the condensate due to improperly designed systems. Horizontal return lines, inadequately pitched, are particularly sensitive.

The carbon dioxide in the steam is not usually caused by the carbon dioxide in the feedwater because proper deaeration removes the latter. However, if bicarbonates are present in appreciable amounts, they decompose in the boiler to form carbon dioxide as follows:

$$2\,NaHCO_3 \xrightarrow{\text{1st step}} Na_2CO_3 + H_2O + CO_2$$

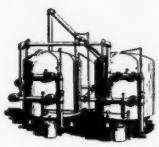
$$Na\,CO_3 + H_2O \xrightarrow{\text{2nd step}} 2\,NaOH + CO_2$$

The first step is always complete. The second ste, however is usually only 80 per cent completed. Therefore, the amount of CO_2 formed in the steam is about 0.79 of the sodium bicarbon



ZEOLITE SOFTENERS

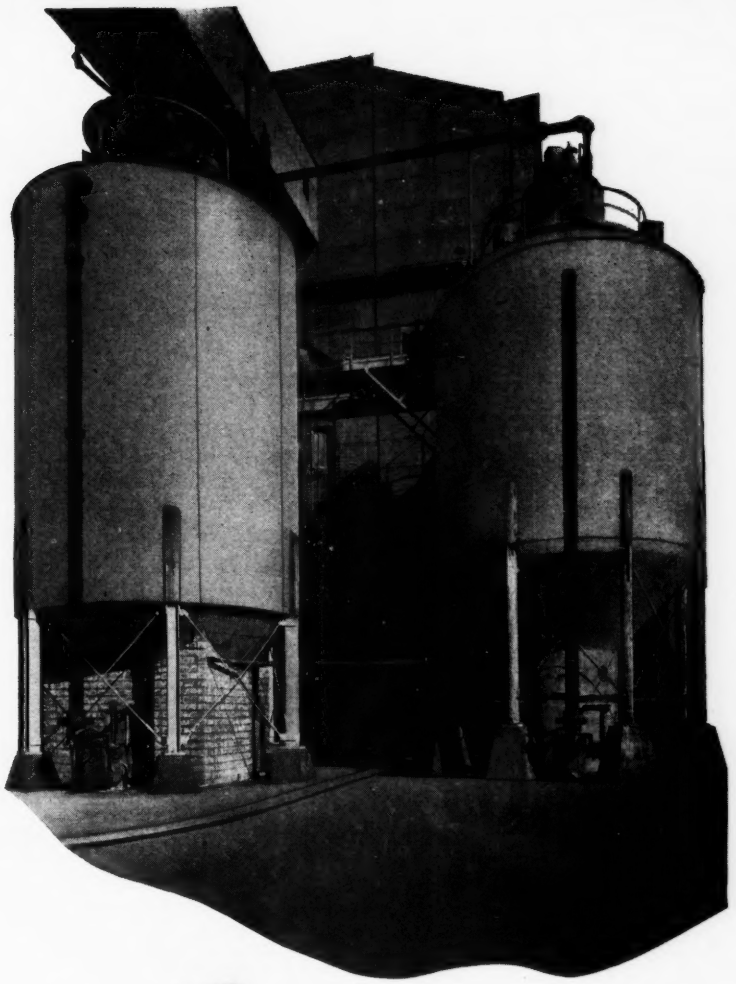
GRAVER



FILTERS

DEMINERALIZERS

REACTIVATORS



THE EQUIPMENT *Experience built*

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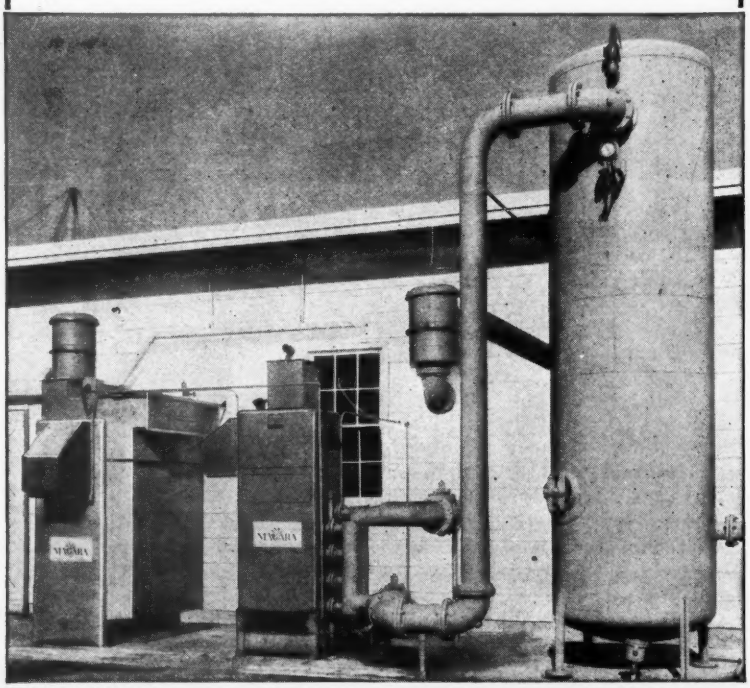

INDUSTRIAL COOLING HEATING • DRYING

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HUMIDIFYING • AIR ENGINEERING EQUIPMENT

ate alkalinity, as $CaCO_3$, plus about 0.35 of the sodium carbonate alkalinity present in the feedwater.

To prevent return line corrosion, the bicarbonates and carbonates must be adequately reduced in the feedwater conditioning plant. This reinforces the need for low alkalinity called for by the ABMA limits to prevent carry-over.

Prevention of Silica Deposits in Turbines

Even if silica deposits are prevented in the boilers, they may form in the turbines. Such deposits are glassy and hard and very difficult to remove. Elaborate caustic washes and, in some cases, sand blasting have been resorted to for their removal. As they accumulate, they play havoc with turbine efficiency. One Eastern Power Plant has estimated that turbine deposits costs them $50,000 per year.

Many theories have been evolved to explain this phenomenon, which is another by-product of higher boiler pressures. The theory most widely subscribed to at present is that the silica is dissolved over with the steam and is held in the steam as a vapor. As the steam expands through the various stages of the turbine, it reaches a pressure and temperature at which the silica vapor is condensed on the turbine blades.

The amount of silica in the steam has been found in many cases to average about 1 per cent of the silica in the boiler salines.

The only remedy thus far proposed is to reduce the silica in the steam by lowering it in the salines.

High pressure boilers, 900 psi and over, produce this turbine silica deposit more frequently than lower pressure boilers because it is assumed that a high pressure and temperature are required to distill the silica. But trouble with boiler pressures as low as 400 psi are being reported.

Precise limits of allowable dissolved silica in the boiler salines have not yet been generally formulated. A tentative schedule of limits that may be recommended is given in Table II.

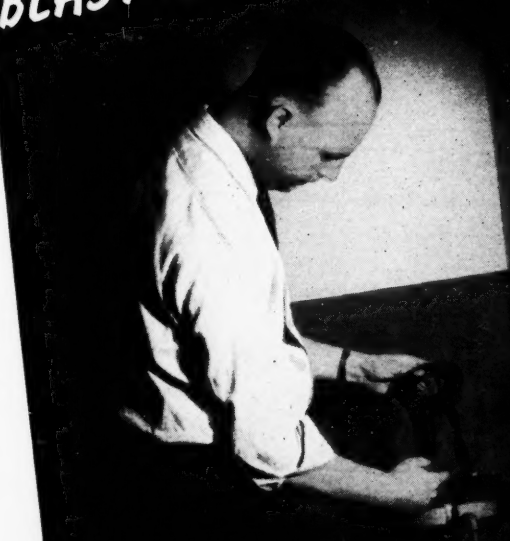
In designing a water treatment plant in any given case, silica deduction must therefore be given case, silica reduction must therefore be given active consideration.

Available Methods of External Water Conditioning

External or outside the boiler, water conditioning has become more complex to meet all these requirements. The following methods are available today:

1. Sodium Zeolite
2. Sodium Zeolite plus acid
3. Hydrogen plus Sodium Zeolite
4. Hydrogen Zeolite plus Caustic Soda
5. Cold Lime Soda with or without silica removal by ferrisul or dolomitic lime or activated magnesia
6. Cold Lime plus acid plus Sodium

OXYGEN BOMB TESTS BLAST RUBBER BREAKDOWN



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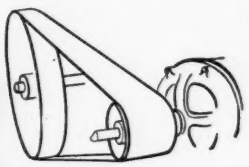
WHAT QUAKER Pre-Tested Products mean to the Power Field



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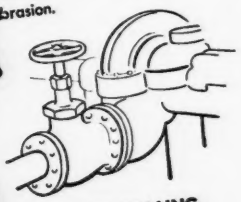

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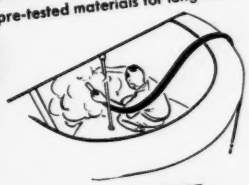

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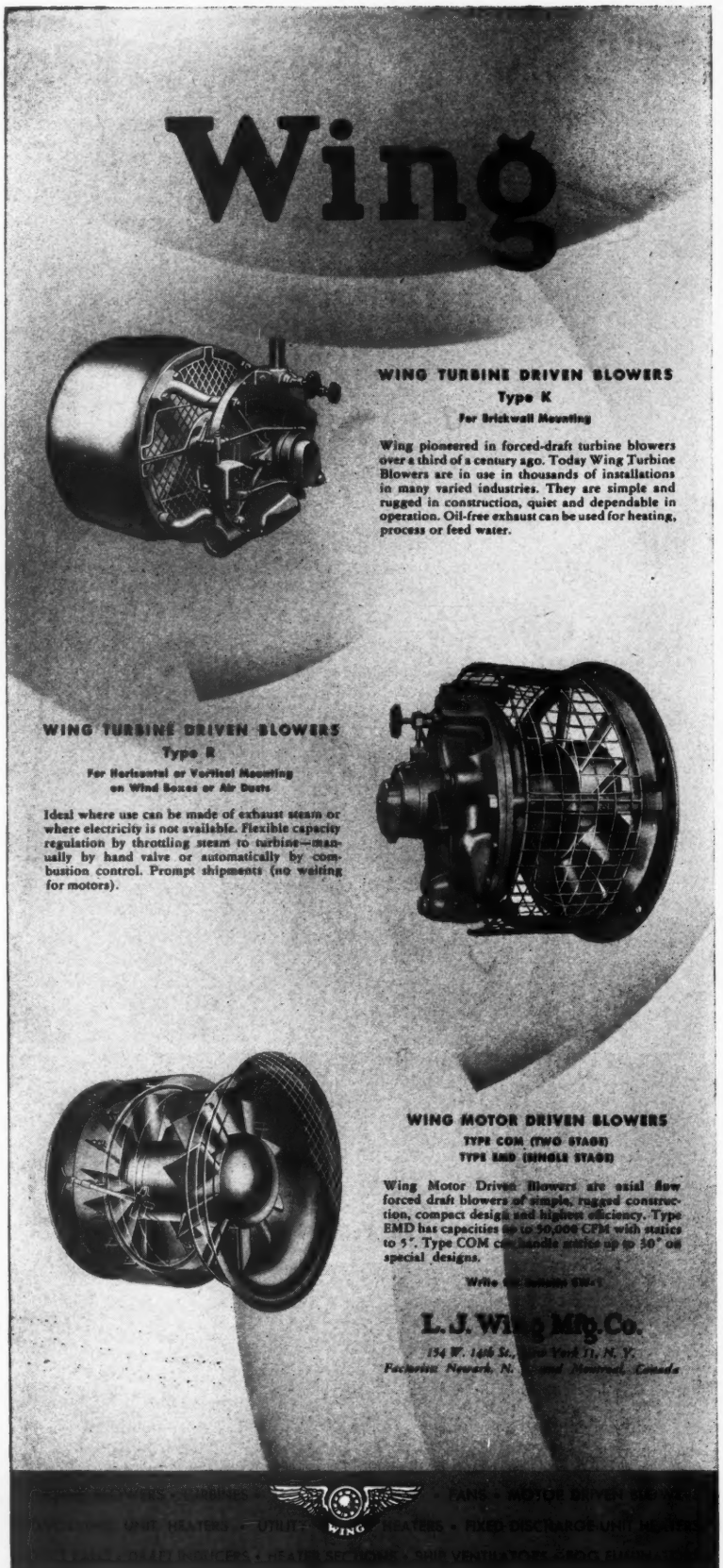
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Zeolite including or excluding silica removal by the same methods given in No. 5.

7. Hot Lime Soda, including silica removal by dolomitic lime or activated magnesia
8. Hot Lime Soda plus Hot Phosphate in 2 stages including silica removal in the first stage
9. Hot Phosphate alone
10. Demineralizing
11. Demineralizing plus anion silica removal units
12. Coagulation and clarification to remove alumina, etc. to precede some of the above methods

This does not take into account internal methods which are also practiced for low pressure boilers, low per cent makeup cases, etc. It also does methods such as phosphate, sulfite, not include supplementary internal treatment to follow the external sludge dispersal etc. which are generally employed.

Obviously, considerable experience, together with sound judgment, are required to select the method that fits any given case most adequately. There is no simple formula that gives a quick answer. To arrive at a reasonable decision in important cases, it is necessary to consider at least five things:

1. Predict the chemical results (analysis of the treated water) by the various methods being considered
2. Calculate the chemical operating costs
3. Estimate the erected cost including insulation, piping, pumps, field welding, storage required, buildings, etc.
4. Determine whether the operating personnel have sufficient training and skill to operate the plant, considering possible variations in the composition of the raw water supply
5. Calculate the boiler blowoff required to keep under the limit of total solids or silica in the boiler saline and evaluate the heat wasted in the blowoff, considering the heat balance and how the heat of the blowoff can be absorbed efficiently into the feed system.

This is a laborious study and is only justified for large plants. Short cuts must therefore be made using experience to eliminate the methods that are not likely to fit the case. The chart shown in Fig. 1 graphically gives the comparative chemical results obtained by a number of these methods when treating an assumed water.

NOTE: This is the first of two articles on trends in modern feedwater conditioning equipment by Mr. Applebaum. The second, which will appear in a subsequent issue will consider a number of case studies showing how the methods discussed in this article are applied in actual practice.

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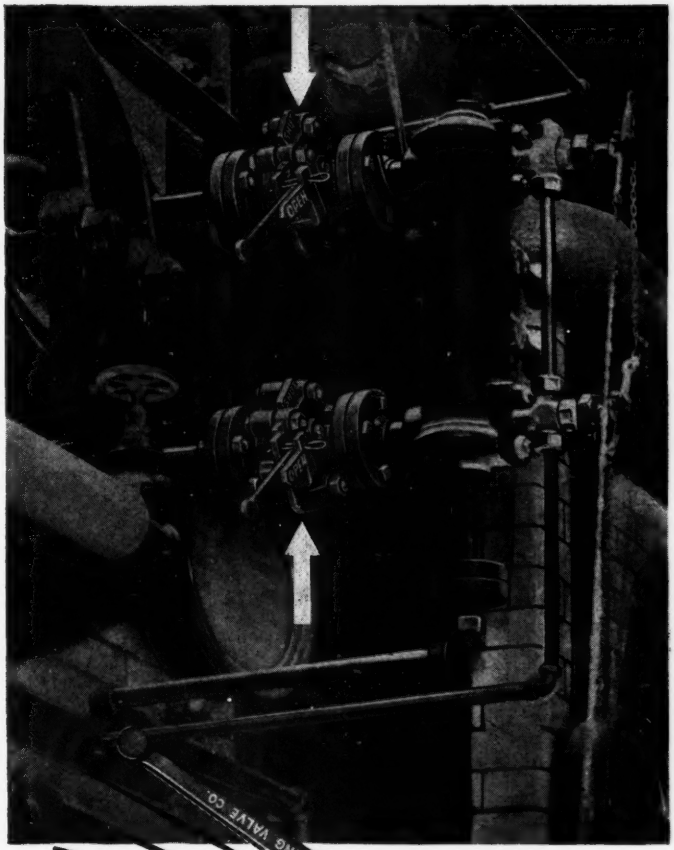

Without effective valve protection at the water-gauge, the breaking of the glass usually compels a boiler shutdown during the emergency. Such breakdowns bring contingent losses all down the line — losses far greater than the moderate cost of EVERLASTING Water-Column Valve protection.

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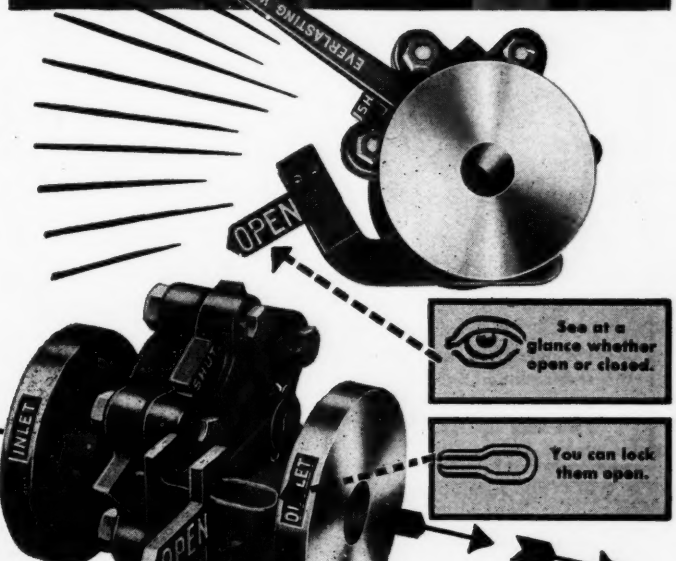

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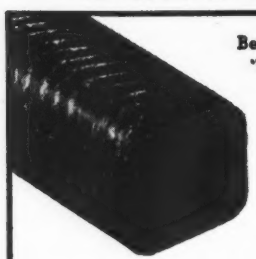

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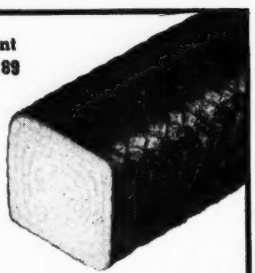

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ELECTRICAL CONTACTS

(Continued from page 63)

ducting film on the surface of the contacts, insufficient contact pressure, or the wrong contact material. Non-conducting films are caused by oxidation of the contact material due to heavy arcing or overheating, by atmospheric corrosion caused by prolonged exposure to high temperatures, high humidity and active chemical vapors or gases, and by air-borne dirt. In some cases it is possible to recondition the contacts by removing the non-conducting film. A clean file is usually one of the better tools for resurfacing a contact. One should be

One should not hastily condemn a contact.

cautioned against grinding or using abrasive papers on soft contact materials like silver and copper because abrasive non-conducting particles are easily embedded in these materials.

One should not hastily condemn a contact because its surface appears roughened and discolored. In the majority of the cases, such contacts will still have a low contact resistance and more harm than good will be done by resurfacing such a contact. An abnormal voltage drop across the contact or a high contact temperature rise while carrying rated current or less may be indications of non-conducting films on the contact surface. On the other hand, there may be an indication of an insufficient force holding the contacts closed, or a loose or high resistance connection elsewhere in the load circuit of the switch. A careful diagnosis is important. In a number of cases, excessive contact temperatures have been caused by a switch carrying currents which are well above its rating.

Contacts have been known to overheat in air circuit breakers which have been closed and conducting currents for long periods of time, sometimes measured in months or years. These troubles have been traced to atmospheric corrosion of the contact surfaces and are most prevalent in humid atmospheres. Such cases could be minimized by simply manually operating the breakers intentionally under load. If this were done at intervals of 6 to 10 weeks, the arcing at the

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contacts would help to keep the surface clean and minimize contact heating.

Arcing at the contacts is another source of contact heating, and the rate at which heat is generated is a function of the intensity of arcing and the number of times that the contacts operate in a given period. If the contacts operate frequently, such as in a vibrator or a regulator, the heating due to arcing may be appreciable even though the energy of any one arc may be low. Heavier contacts and heavier backing members will help to carry the heat away from the contact surfaces faster and hold the contact temperatures to a lower value in these instances.

Contacts Fail to Pass Current

Where contacts close and fail to pass current, the cause is usually badly oxidized or corroded contacts, or excessive contact wear which has progressed to the point where the contact surfaces fail to touch when the contacts are in the closed position. When these conditions exist, a volt-meter connected across the points will indicate a very high voltage or it may even measure full circuit voltage. When the fault is due to excessive oxidation or corrosion the surfaces of the contacts have reached a state of extremely high contact resistance and the causes again have been excessive arcing or very corrosive or dirty atmospheres. Such contacts should be resurfaced or replaced.

All contact materials do not form high resistance oxides under heavy arcing conditions. Instead, they may wear away at an excessive rate. Usually when the wear is excessive the switch is too small for the application or the wrong type of switch has been used.

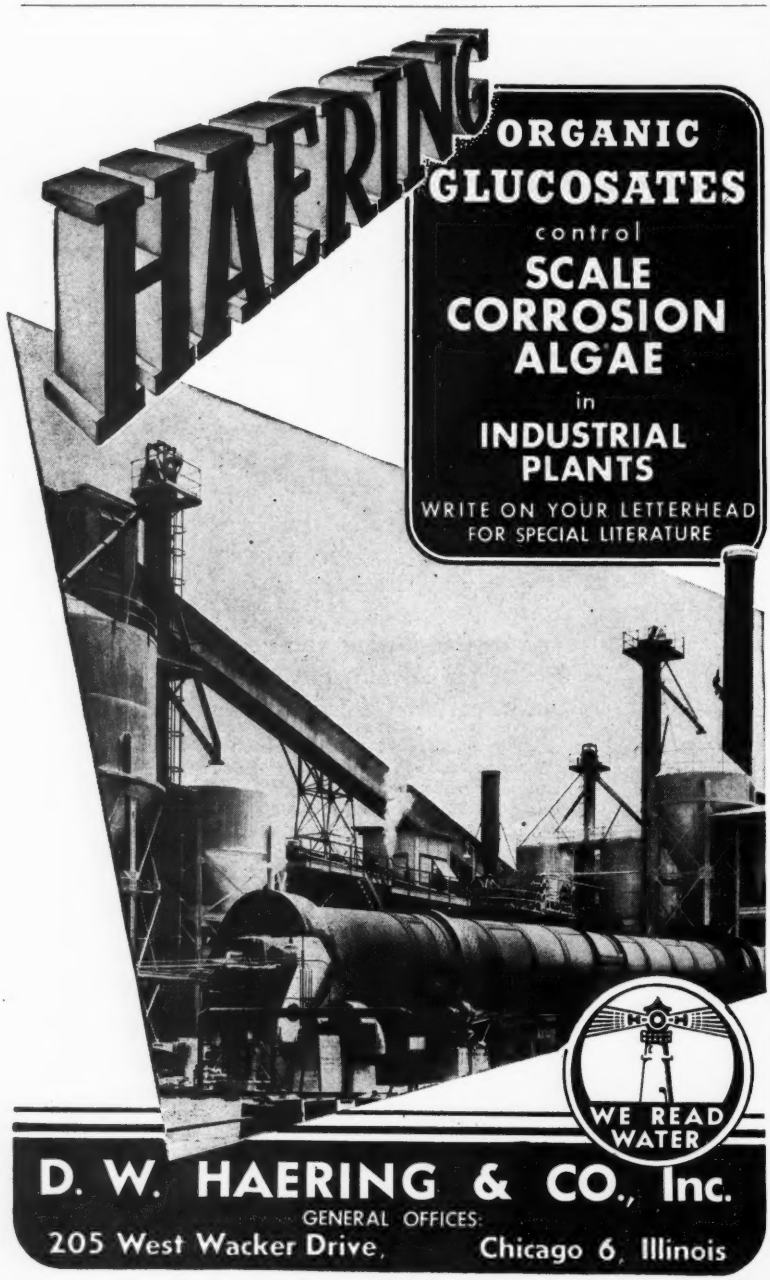
When a switch is closed and current does not flow, in many cases the failure is at some point other than at the switch. There may be an open circuit in the circuit or in the lead. A fuse may have blown or a circuit breaker may have opened.

Transfer of Contact Material

Transfer is a migration of contact material from one contact to another. It leaves a crater in one contact and produces a build-up of contact material on the face of the mating contact. The phenomena which causes transfer is related to the polarity of the voltage applied to the circuit in which the switch operates, therefore, it occurs most commonly in d-c circuits and rarely in a-c circuits. There are different phenomena which contribute to the formation of meta' transfer, and the direction of transfer may be either to the positive contact or to the negative contact depending on which phenomenon is the controlling factor. Every time contacts make and break a current, there is a tendency to transfer metal to the negative contact, and the rate of transfer tendency increases with increasing currents. When contacts arc on opening the circuit, due either to high circuit voltages or high inductances in the circuit, there is a tendency to transfer metal to the positive contact. If the latter phenomenon is of greater influence than the former, the resultant transfer will be to the positive contact.

Excessive transfer may lead to failures of different forms. In some cases the build-up may interlock with the crater and the contacts will hang closed mechanically. In some cases the configuration of the build-up differs from that of the crater and the build-up interferes with the closing of the contacts. This sometimes happens in vibratory systems in control devices and it changes the calibration of the device. Some failures are due to the fact that the crater completely penetrates the contact facing material and the contacts become high resistance because the arc then attacks the backing material whose exides are non-conducting.

Transfer can be controlled to a large extent by varying circuit constants. Especially where arcing causes excessive positive transfer, the arcing and transfer may be reduced by such arc suppression circuits as condensers or resistors, or combinations of the



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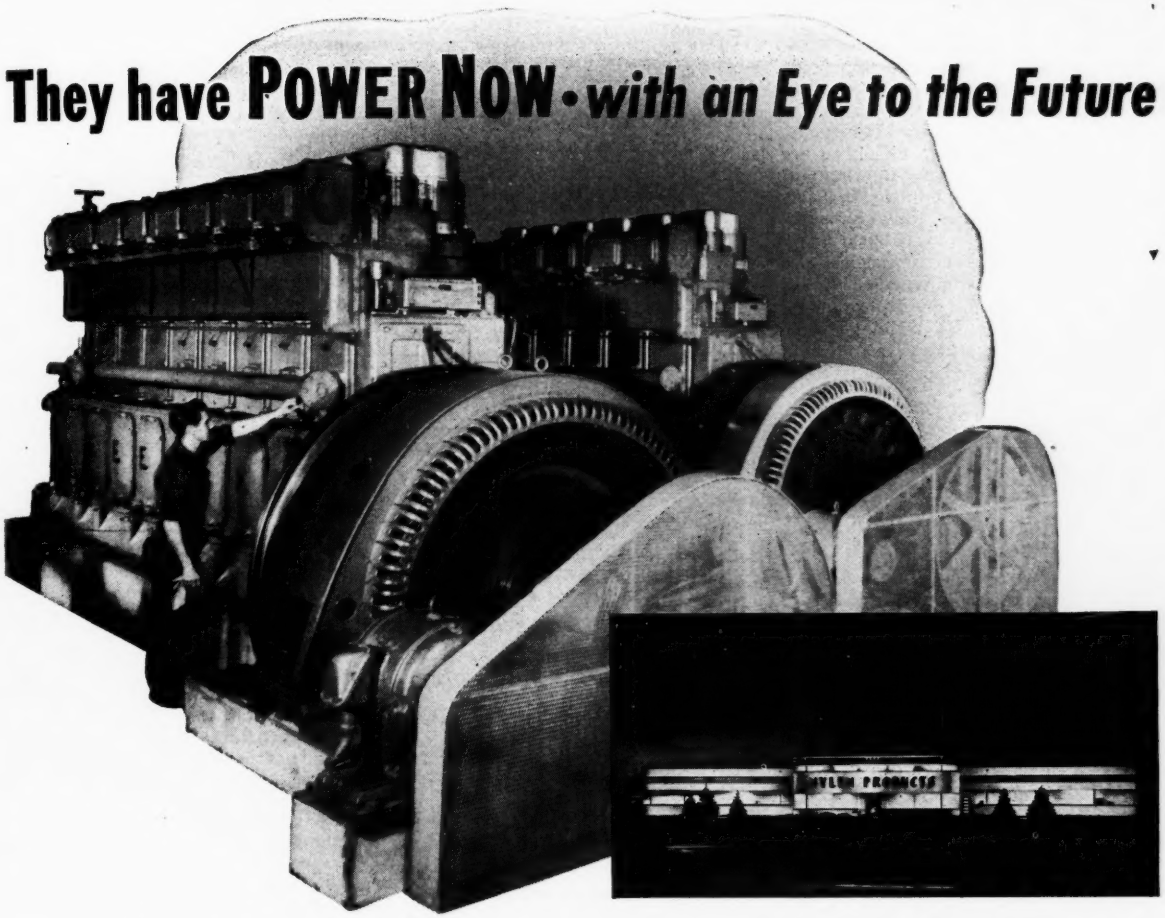

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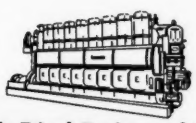

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two across the contacts, or the inductance in the circuit, or both. Sometimes it is possible to change from excessive positive transfer to excessive negative transfer by making too drastic a change in the circuit. Frequently a condition of a slight amount of arcing is beneficial in limiting the amount of negative transfer that may occur if the arc is entirely eliminated. In some cases it may be desirable to change to a different contact material to improve transfer tendencies. Such measures as circuit changes or changing contact materials can be somewhat critical and it may be advisable to consult with switch manufacturers or manufacturers of contact materials before making such changes.

Summary

In the course of routine maintenance of switch gear, the contacts should not be resurfaced just because they appear somewhat roughened and discolored. More harm than good may result from such practice. Contacts should be resurfaced only when there are definite indications that their surface condition is contributing to the faulty operation of the device.

If a contact making device requires frequent attention, the switch mechanism such as bolted and riveted electrical connections, springs, adjustments, etc., should be checked. When a device has given trouble ever since its installation, a different type of switch or one of a higher rating may be needed. In some instances, the performance might be improved by changing contact materials. It is strongly recommended that a manufacturer of contact materials or switches be consulted before making such changes.

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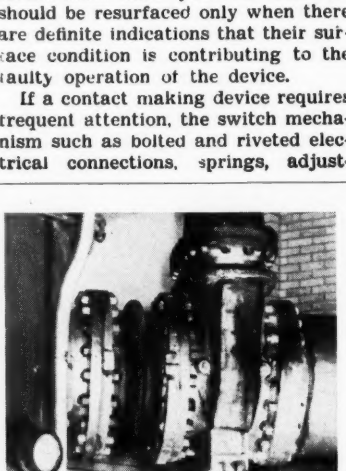

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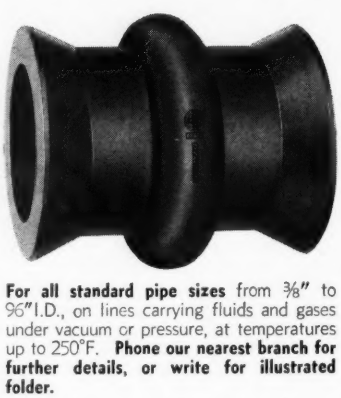

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AUTOMATIC ROLLING-IN OF SMALL TUBES

(Continued from page 65)

pander head in his left hand, grasping the handle of the motor in his right hand.

As soon as the expander head has been introduced to the desired depth into the tube, the operator pushes the tool forward. This action forces the spindle toward the motor, engaging the gears that rotate the spindle in a clockwise direction for expanding the tube. Simultaneously, the auxiliary switch is shifted into the position shown in (b) Fig. 3. In this position current passes from the 115 v source through the motor, the 0-3 amp a-c meter, the coil of the 3 v relay (upper left), Contact B of the 115 v relay (upper right), the auxiliary switch ("green" contacts "white"), and back to the source. Current cannot pass through the parallel circuit from the source directly to the 115 v relay because the two Contacts A and C, one on the 6 v relay and the other on the 115 v relay, are both open.

The operation of expanding the tube end proceeds and the value of current to the motor increases. When the value of current reaches that necessary to operate the 6 v relay this relay operates, closing Contact A. The value of the current to operate the 6 v relay is adjusted when necessary by means of the 25-ohm 150 watt rheostat shown in Fig. 1. The dial of this rheostat is shown at the left of the control cabinet in Fig. 2. Closing Contact A in the 6 v relay establishes the circuit through the actuating coil of the 115 v relay, causing it to operate. This operation opens Contact B and closes Contact C of this relay. These two events happen in quick succession. Opening Contact B cuts the circuit to the motor and the motor stops, ending the expanding of th tube end.

The Locked Circuit

When Contact B of the 115 v relay is opened, the circuit through the actuating coil of the 6 v relay is also opened and Contact A of this relay returns to its normal position. This in turn opens the circuit that allows current to flow in the actuating coil of the 115 v relay. However, the operation of the 115 v relay closes Contact C, and the flow of current is maintained through the coil of this relay. The circuit to the motor is then broken and cannot be re-established until the operator of the expander tool

exerts a pull on the tool. This pull shifts the spindle of the expander axially to the position shown in (a) Fig. 3, the position for starting the motor and operating the expander tool in backing it out. The motor backs out the expander and the cycle of operations is completed.

The external appearance of the new current-limiting switch is shown in Fig. 2. At the bottom of the cabinet are the three receptacles for receiving the electrical connections. The one on the right is the two-wire receptacle for the connections to the source of 115 v single phase current. That in the middle is the two-wire receptacle for the cord to the motor. That on the left is the three-wire polarity connection for the auxiliary switch. The cords connecting the expander tool to the auxiliary switch may be of any convenient length; 10 ft has been found to be satisfactory. When the door of the switch cabinet is open, the dial of the 25-ohm, 150-watt rheostat for controlling the value of cut-off current is seen to the left of the ammeter. The "tell-tale" red lamp in the upper central part of the panel is connected to the circuit through the 115 v relay and lights when this relay operates at the termination of the joint-expanding operation. This lamp is visible from the outside when the cabinet door is closed.

Current-Limiting Switch

The new current-limiting switch has been used to date in connection with the installation of the tubes in a steam condenser serving a 75,000-kw steam turbine recently put into operation. The operator who handled the expander tool was not particularly experienced in using motor-driven tools. However, this operator was easily able to average 2500 tube ends expanded in an 8 hr day, when using the new switch. The same switch has been used in replacing tubes in four other heat exchangers. In the case of one of these, nine different men operated the tool; only two of these men had previously operated tube-expanding equipment. The tube ends in all of these heat exchangers were satisfactorily expanded. This experience demonstrated the fact that the successful use of the new tool is not dependent on the previous experience or skill of the operator who uses it.

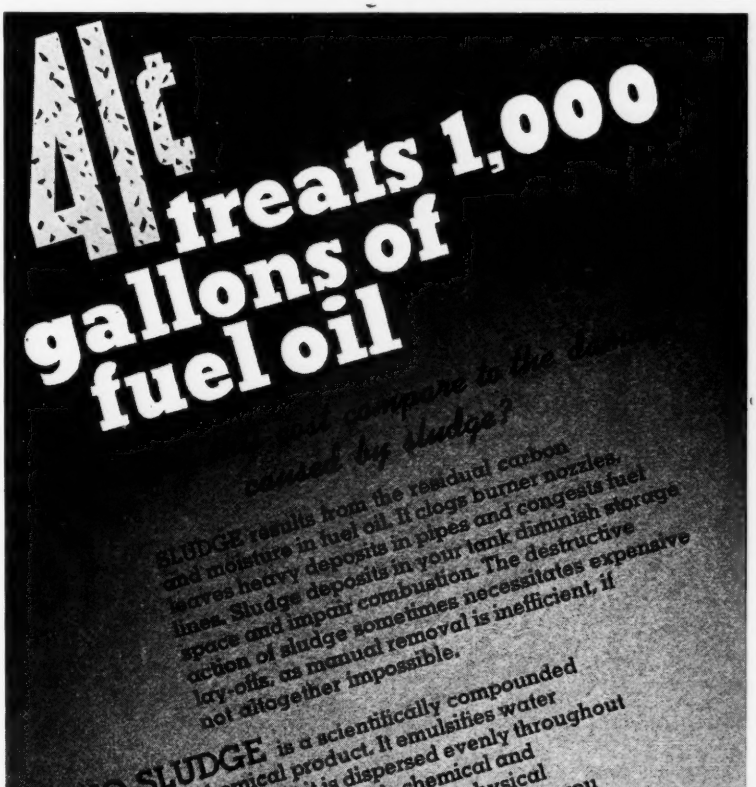
In order to make a record of the rate at which tubes ends were being expanded in the condenser mentioned, a recording ammeter was connected into the circuit of the expander-tool motor. The purpose in making the records was carefully explained to the operator and he was asked to proceed with the work as though no recording device was counting his operations. The recording was continued for one-half hour. A representative record showed that the operator was producing about seven joints a minute for the period of time covered by the record. When allowance is made for the necessary interruptions that occur in erection work, the expanding of 2500 tube ends in an 8 hr day (slightly more than five per minute) is in reasonable agreement with this record.

Summary

This article calls attention to the unsatisfactory features of the older current-limiting switch used in connection with automatic tube-expanding tools and describes a new type of switch that has none of these objectionable features. The results obtained in expanding 22,000 tube ends in a steam condenser recently erected and in repairs to several heaters are given. These results fully met the high hopes held for this new switch.

While it cannot be claimed that this new switch is a perfect device of its kind, yet it is true that by its use the rate of expanding ¾ in. condenser tubes into tube sheets has been more than doubled when compared with the best record made with the older type of switch. The operating characteristics of the new current-limiting switch are such that the high rate of producing satisfactory tube joints mentioned above was possible. The reaction of the operator of the tool toward the new switch was satisfactory.

The author is indebted to Mr. Frank F. Fisher, General Foreman of Mechanical Erection, The Detroit Edison Co., for helpful suggestions and criticisms in preparing this article. Mr. Fisher suggested the need of an im-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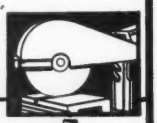

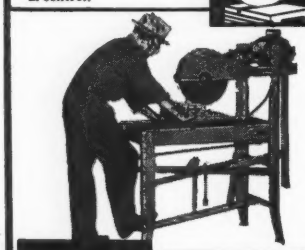

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proved switch and brought together the persons who were engaged in the design, construction, and testing involved. The switch was designed by engineers in the Relay Division, Electrical System, The Detroit Edison Co.

SAVINGS POSSIBLE BY PROPER CONDENSATE RETURN SYSTEMS

(Continued from page 72)

up required is added to condensate in this receiver and passes through tubes of vent condenser before entering receiver. The quantity of make-up is regulated by the water level in this low pressure receiver as shown in Fig. 1. Air and non-condensate gases are vented from receiver through an automatic air valve. Condensate and make-up are pumped into intermediate return line and mix with intermediate pressure returns as they enter receiver No. 2.

The system indicated in Fig. 1 is sufficiently flexible to work well with any usual load variations or variation of the ratios between high pressure, intermediate and low pressure systems. The temperature of the water in receiver R1 will vary from 210 F down to about 120 F depending on percentage of make-up. The temperature of water in receiver R2 will vary from about 280 F where the ratio of intermediate pressure steam to low pressure steam is high down to about 210 F where this ratio is low. The temperature of water in receiver R3 will vary from about 325 F where the percentage of high pressure steam is high relative to the total used down to about 260 F where it is low.

As stated above, with this system the condensate can be returned to the boiler at a temperature of from 260 F to 325 F, depending upon load, as against a temperature of about 210 F where all condensate goes to a single vented receiver. The make-up required will be reduced to about 40 per cent of that required where a single vented receiver is used and the fuel required to produce the steam will be reduced about 7.5 per cent.

The annual fuel saving for the plant shown in sketch, if it is assumed to operate 2500 hours per year at an average of 70 per cent capacity will be equivalent to about 82.5 tons out of a total of 1075 tons. The annual saving in make-up water will be about 12,000 cu ft which may also be a factor where water has to be purchased or treated.

A system of this type will, of course, have to be especially designed to suit the requirements of each case to which it is applied and the number of steps that will prove most economical determined.

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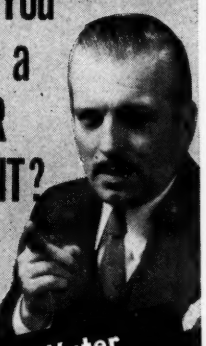

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open heater and are there used to heat the make-up will, in most cases prove as economical and more simple. If a deaerating heater is used there should be a live steam connection to it, through a suitable reducing valve, to keep the heater full of steam under a slight positive pressure at all times if the efficient removal of air and other dissolved gases is to be expected.

PRACTICE OF THEORY VS. THEORY OF PRACTICE

(Continued from page 88)

poorer refractory materials ,outlasted the present gravity settings tv to one. Perhaps the key to this is in the statement by an old fireman of some twenty years ago, who had then outlived his usefulness. He said, "What's the matter with the engineers that they set boilers so high? Now if you watch your wife heat the teakettle on the old wood stove, you'll see that she puts the kettle right down on the fire. That the way to boil water!" (Fig. 6).

That belief seems to exist in some parts of the country even today! Of course the old solid walls of those days lasted longer. The obvious reason is that there was insufficient furnace volume to properly burn the fuel, and as a consequence, instead of the gases heating the boiler, the water in the boiler chilled the gases before combustion was completed. But who cared—fuel and labor were cheap then.

Refractory companies have gone to great lengths proving the theory that a specific grade refractory under a specific load softens and deforms at a lower temperature than the same refractory without the superimposed load. Obviously, the heavier the load on the lower courses of brick, the lower will be the temperature at which they will soften and deform. Theoretically, the use of headers, tying a solid refractory wall to an outside wall of red brick will partially suspend the refractory wall and prevent softening of the lower courses. In practice, however, it is another thi g. The refractory wall expands at the first application of heat. You know the rest; in due time the headers shear, the wall twists, causing additional stresses to the lower courses and the deformation is actually accelerated. Only a suspended wall, with ample provision for absorbing expansion can allow the use of higher temperatures without destructive deformation. As an example, we had a case a few years ago, of a public utility boiler which was fired with coal tar. It seems the ireman's job was a monotonous one, for he apparently fell asleep one night and while he slept the burners went out of adjustment. Carbon soot was formed to such an extent that the breeching was quickly filled with soot deposit which caused the furnace to become a retort. Temperatures within he furnace were estimated to have

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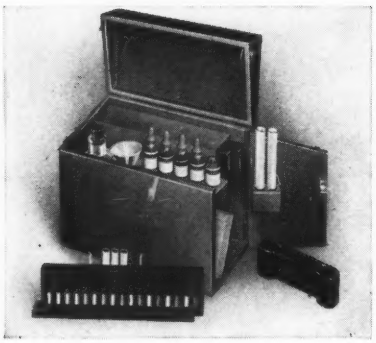

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Taylor Boiler Water Comparators help you control corrosion and scale by giving you fast, accurate checks on pH and phosphates.

Anyone can operate the easy-to-use Taylor Comparator, and make determinations of pH and phosphates in one to two minutes. Accuracy is assured by the unlimited guarantee against fading placed on all Taylor Liquid Color Standards. Nine standards, a complete set for each determination, are permanently enclosed in one plastic slide, eliminating the need for handling fragile, single standards.

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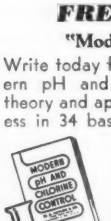
Write today for your free copy of "Modern pH and Chlorine Control." Gives theory and application of control of process in 34 basic industries . . . useful to all men concerned with boiler maintenance. Also illustrates and describes Taylor Sets. See your dealer for Taylor equipment.



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reached 3200 F. The inner portion of the refractories shrank more than a quarter of an inch for each foot in height. But the suspended walls withstood this shock of shrinkage. In fact, the boiler was operated continuously for nine months thereafter before any of these tiles were replaced. If it had been a gravity wall, it probably would have collapsed while the fireman slept.

During a lifetime of experience with industrial heat enclosures, we know the meaning of the Practice of Theory versus the Theory of Practice and offer the following points to be considered when designing a sectionally supported refractory wall enclosure!

1. Possible erosion of refractories.
2. The depth to which the tiles can spall without injury to the supporting structure.
3. The ability of the refractories plus the outer insulation, to keep the outer wall temperatures to a minimum.
4. The stability of the wall, it's ability to resist, or flex, with pulsations, such as puffs, minor explosions, etc., so frequent when firing with oil, gas, or pulverized fuel.

Often, many engineers consider the first three points, but not the last. Too thin a wall, especially in those areas back of the boiler tubes where the wall is almost invariably punctured by numerous doors makes it particularly vulnerable to vibration caused by pulsations. In time, leaks develop around the door openings. As far as practical, the wall should be of uniform thickness throughout in order to simplify the inventory of repair parts and to permit a more uniform external appearance. In the years to come, there will no doubt be great strides in the field of heat enclosures. And for the sake of economy and progress, may we suggest that the practice of theory be thoroughly investigated before the theory is put into practice.

HOW YOU CAN CIRCUMVENT THE SODA ASH SHORTAGE

SODA ASH is one of the most important chemicals used in the treatment of boiler feedwater. The scarcity of this material during the past year has caused many difficulties, particularly in lime-soda softening where large quantities of soda ash are required.

To maintain boilers on line during temporary interruptions in soda ash supply or under continuously curtailed supply conditions constitutes a problem often capable of solution by altering chemical balances throughout the system or by substituting treatment chemicals not usually considered feasible from an economic standpoint.

To many of the plants troubled by the soda ash shortage, engineers have applied the use of caustic soda as a

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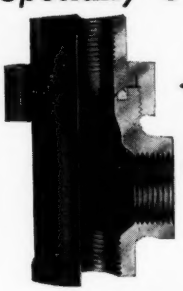

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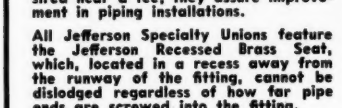

● The capacity of the IMO is increased by high speed operation. This compact pump can be directly connected to the driving machine without bulky speed reduction gearing.

● IMO Pumps can be furnished for practically any capacity and pressure required for oil, hydraulic-control fluids and other liquids.

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IMO PUMP DIVISION of the
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substitute in some cases for both lime and soda ash. Boiler water recirculation to hot process softeners also could frequently be applied, thereby effecting substantial reductions in the quantity of soda ash required. In some cases, the temporary conversion of filter units into zeolite beds permitted satisfactory operation by blending the raw water and zeolite effluents prior to softening with lime alone.

How Caustic Soda Can Be Used

Caustic soda frequently was in as short supply as soda ash, but was available for use in certain instances. Depending on the characteristics of the raw water, complete softening may be brought about by caustic soda alone or by a combination of lime and caustic soda, as discussed in *The Betz Indicator*. In general, caustic soda alone can be utilized for softening waters that possess a methyl orange alkalinity that exceeds half of the calcium content by 15 to 30 ppm. Where methyl orange alkalinity exceeds half the calcium content of the water by more than 30 ppm, a combination of lime and caustic soda should be utilized to avoid an excessive alkalinity of the softened water. Waters that possess a methyl orange alkalinity less than half the calcium content can be only partially softened by caustic soda alone.

Boiler water recirculation can frequently be used to conserve on soda ash and, in some cases, the application of recirculation will totally eliminate the need for soda ash. The amount of soda ash savings is dependent on raw water characteristics. In general, however, those waters which consist predominantly of carbonate hardness will show a greater soda ash savings through the use of boiler water recirculation. Non-carbonate hardness waters involve only a minor percentage savings in soda ash through recirculation.

Where such measures were not applicable because of raw water characteristics or physical limitations, barium carbonate, a material not in short supply, was considered an emergency substitute for soda ash. Barium carbonate was applied not with the primary intention of reducing the sulfate content of the treated water, but rather to obtain the advantage of the sodium carbonate produced as a by-product of sulfate removal.

In lime-soda softening, soda ash is needed to remove calcium non-carbonate hardness present in the raw water and also to precipitate the calcium chloride, calcium sulfate, etc., produced in the precipitation of magnesium salts by lime.

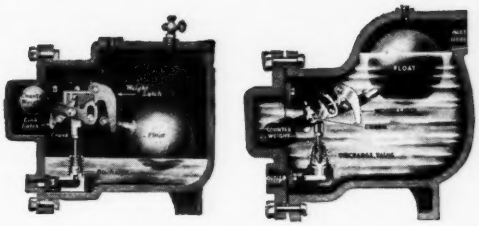
Sodium carbonate is formed by the reaction between barium carbonate and the sodium sulfate present in the raw water. The sodium carbonate is then available for use in the reactions. In addition, calcium sulfate and magnesium sulfate can be removed without the use of soda ash.

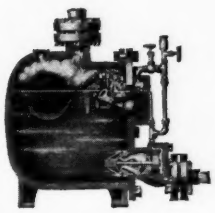
In some cases where the natural

Nicholson Weight and Piston-Operated Traps Help

SOLVE CORROSION PROBLEMS

Right, Nicholson weight-operated traps for steam, air, gasoline; pressures to 200 and 650 lbs. Other models to 1500 lbs.





Above, Nicholson piston-operated steam trap, 2 to 650 lbs. pressure. Large capacity for steam purifiers, etc.

All working parts of Nicholson traps are made of stainless steels or bronze, carefully selected to give permanent resistance to corrosion. Other trouble-free features resulting in the adoption of Nicholson traps by an increasing number of large users: positive fluid seal keeps valve tight; not easily affected by dirt, pulsation, pressure variations; non-wire drawing; rugged to take unavoidable abuse.

TRAPS FOR EVERY POWER APPLICATION. 5 thermostatic types for steam press. to 225 lbs.; 2 expansion types, press. to 250 lbs.

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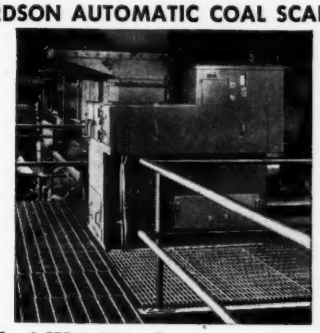
CONSTANT CHECK | ON BOILER EFFICIENCY

RICHARDSON AUTOMATIC COAL SCALE

SPOTS fuel losses... CUTS steam costs...



One of two Richardson Automatic, Stationary, Floor-Mounted Scales supplied complete with bunker gate and distributor spout to feed stokers. Scale accessible on all four sides.

Install a Richardson Coal-Weighing System and you have continuous readings of consumption—at a glance—which show the efficiency of your boilers. By weighing and recording every pound of coal burned individually by each boiler on the line, you can compare evaporation rates and k.w.h. output; tell which boiler is not "delivering" its quota of steam.

The Richardson complete bunker-to-boiler weighing and coal feeding system is adaptable to the space and needs of large and small plants. Richardson Coal Scales are built for floor-mounting, in both portable and stationary models mounted at their mid-section, or as elongated conveyor-scale units.

Don't chance costly coal consumption. Keep your records straight—*by weight!* Write for Bulletin No. 1143.

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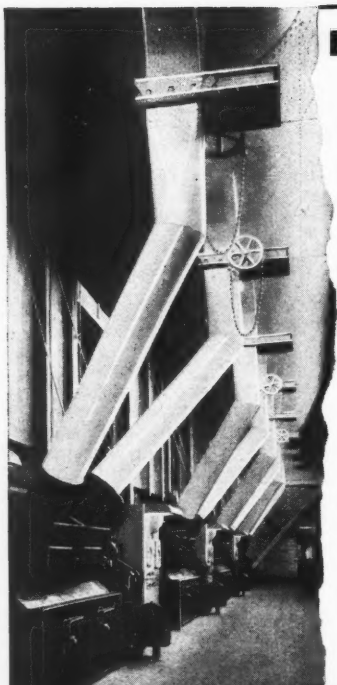

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...and INSTALL BEAUMONT ANTI-FRICTION GATES

● Many utilities are replacing their present gates with Beaumont improved anti-friction type gates. Since the first order from one utility in 1942, many repeat orders have been received for installation in this company's other power plants.

In all cases, these gates have given very satisfactory service. According to one user, "No trouble whatever has been experienced opening and closing these gates—and no maintenance has been necessary other than periodic greasing".

Many leading plants throughout the country are finding it economical and time-saving to install Beaumont trouble-free type gates such as those pictured at left. Follow the leaders and do the same. These gates are made in sizes from 14" to 30". Request complete information.

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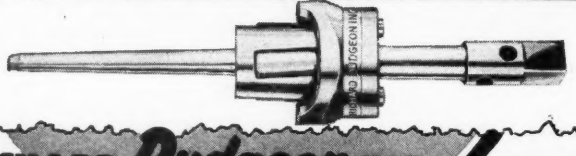
Highest quality tool obtainable for all general tube rolling in railroad maintenance and boiler repair work. Simplified design provides unusual economy of operation. Hardened guide ring bears against hardened one piece frame for maximum resistance against grit and scale. Rollers are reversible



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sodium sulfate content of the raw water was insufficient to produce the desired sodium carbonate excess required in the softener effluent, it was necessary to feed sodium sulfate to the softener and thereby produce soda ash directly.

Theoretical efficiency in the use of barium carbonate to produce soda ash has not been obtained in either laboratory tests or full scale plant operation. Barium carbonate can be used in both hot and cold softening, but its action is more efficient in the hot.

The insoluble barium sulfate precipitate formed in these reactions is removed along with the calcium carbonate and magnesium hydroxide through sedimentation and filtration as in normal lime-soda softener operation. Inasmuch as barium salts are toxic, qualitative barium determinations were conducted on the softener effluent, and the efficiency of filtration was also checked closely to make certain of the removal of the finely divided barium sulfate precipitate. Only small traces of barium were observed.

The use of barium carbonate in place of soda ash does not require alteration of normal softener control procedures, so no disadvantage has been encountered in this phase of operation. Lime control can be established on the basis of maintaining certain residual hydrate alkalinity values, and barium carbonate can be regulated to develop optimum excess carbonate alkalinity concentrations. Determinations for excess sodium sulfate would not be imperative since experience proved that the feed of this material, if required, could be adjusted in direct ratio to the barium carbonate charges.

Some state health authorities consider the barium-containing sludge to be a health hazard and will not permit it to be dumped in waterways. Potential users of the barium carbonate process who must discharge sludge to streams and rivers should seek information concerning the attitude of their state health authorities before installing the process.

Assuming chemical reactions to proceed at 100 per cent theoretical efficiency, the cost of the soda ash thus produced is 6.2 cents per pound. This cost is based on 3.25 cents per pound for barium carbonate of 98 per cent purity and sufficient natural sulfate content of the raw water to complete the reaction. Where sodium sulfate must be supplied for the reaction, based on a cost of 2.1 cents per pound for this chemical, the cost of thus producing soda ash is 9.0 cents per pound. Where higher than theoretical quantities of barium carbonate and sodium sulfate are necessary, the cost of producing soda ash is correspondingly increased.

These data are abstracted from the article entitled Substitutes for Soda Ash in the Treatment of Boiler Feedwater, by W. A. Tanzola, R. L. Reed, and J. J. Maguire of W. H. & L. D.

Betz. This article, copyright by The American Chemical Society, appeared in the November, 1947 issue of *Industrial and Engineering Chemistry*, Vol. 39, No. 11, pages 1440-1443. It is reprinted as Betz Technical Paper No. 110 and may be obtained free on request to W. H. & L. D. Betz, Gillingham & Worth Streets, Philadelphia 21, Penna.

SYNTHETIC FUEL DEVELOPMENTS

RECENT ANNOUNCEMENTS indicate that commercial distribution and uses are being carefully analyzed for the products of the synthetic gasoline and oil plants now under construction, as reported in these p~ges during the past 2 years.

Texas Development Corp. is now prepared to license anyone in the petroleum industry to manufacture synthetic gasolines by means of the Hydrocol process, according to a recent announcement by its president, W. M. Stratford. A long-term contract has been signed by U. S. Industrial Chemicals, Inc., and Stanolind Oil & Gas Co. for the sale by the former of all water-soluble oxygenated chemicals to be produced in the first two synthetic plants now under construction in Texas and Kansas. Plans are also under way for erection of U. S. Industrial plants at these two locations.

Discussing the new process with the press, L. C. Kemp, Jr., Director of Research for The Texas Co., announced that a new research center and pilot plants have been established at Montebello, Calif., for the further development of processes for manufacturing of synthetic products from varied sources of supply. Semi-commercial scale pilot plants at Montebello, capable of producing 5000 gal of synthetic gasoline per day, are now operating.

Although basic development work on the new process has been carried on for the past two years, permanent buildings and the new pilot unit structures have just been completed. Work is now under way on the conversion of heavy fuel oils and of various types of coal to synthetic fuel.

Mr. Kemp stated that the new process produces a high quality gasoline with an octane rating of 80 and higher—as contrasted with the old process which gave products with a rating of 20 or lower and which required extensive processing before they were usable in internal combustion engines.

It is estimated the chemicals produced from the Fischer-Tropsch plants in Texas and Kansas may exceed a total of 300,000,000 lb annually, and include ethyl alcohol, methyl alcohol, normal propyl alcohol, normal butyl alcohol, normal amyl alcohol, acetone, methyl ethyl ketone, acetic acid, propionic acid, butyric acid, acetaldehyde, propionaldehyde and butyraldehyde. In addition, U.S.I. will produce esters, higher alcohols, and other

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IF YOU are looking for a simple, economical, and dependable motor operated flow control valve, you can't beat the Davis No. 300. It is equipped with a standard motor assembly, connected directly to the valve stem. Because the motor is adaptable to standard thermostat control, this valve is popular for steam or hot water heating system service, particularly where zone control is desired. Also used extensively to shut off house or processing water supply, in event of fire, diverting entire water supply to automatic sprinklers, operation being accomplished through the sprinkler alarm system.

No. 300 is available in sizes from ½" to 6". Balanced or single seated inner valves for various service requirements. Other designs for higher pressures and larger sizes. Bulletin on request.

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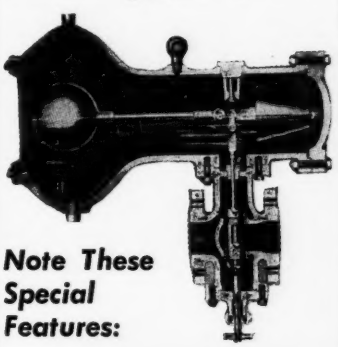

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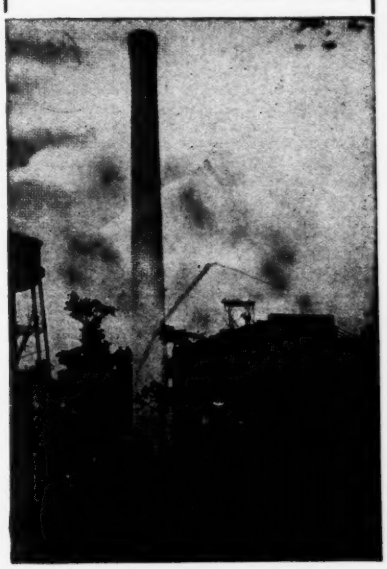

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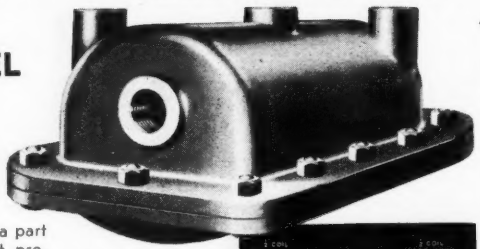

A Whitlock Sampling Cooler as a part of your power plant equipment provides a ready, convenient means of obtaining boiler samples for checking pH values and salt concentrations. **Now available from stock with either Stainless Steel or Copper Tubing,** this unit gives better control by supplying proper samples, free from air occlusions which would affect conductivity cell readings. Built of corrosion-resistant materials and designed for dependable service, the Whitlock Sampling Cooler is now giving excellent results on hundreds of installations.

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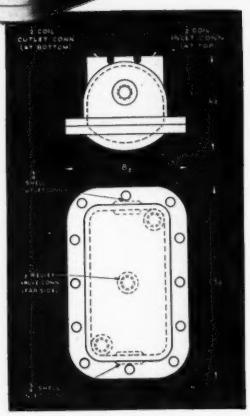

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chemicals for some of the primary products, adding substantially to the number of products made available by this development.

PLASTICS SEALING SLEEVES

A NEW METHOD of insulating magnetic coils with plastics sealing sleeves to form a tough, tight fitting insulation has been announced by General Electric's Chemical Department. The new process, which permits the covering of all inner and outer surfaces in one operation, is accomplished by slipping a sealing sleeve inside the magnetic coil, turning the two ends over the outside and permitting the sleeve to air dry. Use of the sealing sleeves as an insulation enables many coils to be wound as one piece on long mandrels and cut to desired size.

General Electric stated that the sealing sleeves are also finding use as coverings for cable ends, grips for pliers, wrenches and wire cutters, and as temporary protective covers for the storage and shipment of finished products.

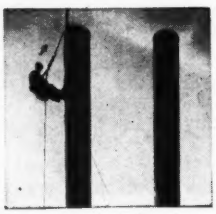
Processing the plastics sleeves calls for a special dilator solution developed by General Electric in which the material is immersed from two to four hours. When expanded to half again its normal size the sleeve is placed in position. As it dries it shrinks to smaller than its original size forming a tight fit around the product.

How PLASTIKSTEEL Can Protect Your Stacks and Tanks

PLASTIK STEEL

PLASTIKSTEEL makes a tight and lasting bond on steel plate and concrete. Use it to protect against sulphurous deposits, prolong the life of stacks and breechings. Ideal coating for drinking water and brine tanks.

It's easier to apply than paint; has no bothersome fumes; time-tested in many different industries. Write today for descriptive folder, or ask for liberal sample to try on your tough lining jobs.



Two Steel Stacks in Sacramento, Calif., being lined with PLASTIKSTEEL.

PLASTIKSTEEL CORPORATION

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"Boiler Repairs Reduced 75%"

writes user of **NATIONAL GIRTH SEAM PROTECTOR**

We have been using the National Girth Seam Protector for several years and they certainly do the job. . . . Have reduced our boiler repairs at least 75% since using these protectors, one of the best investments we ever made.

Von Platen-Fox Co.
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You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

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FOR YOUR FILTERS BROMOX WORKS WONDERS IN HARD WATER AREAS

- BROMOX cleans and sterilizes filter sand without removing sand from filters
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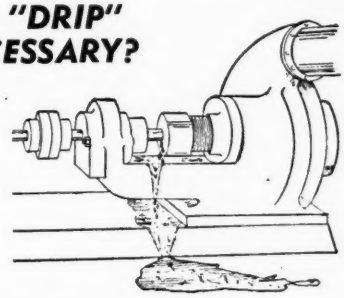

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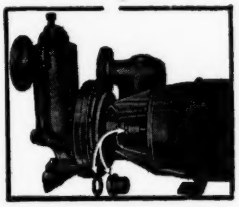

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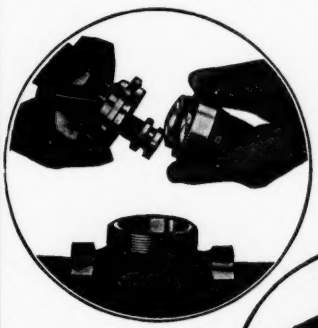

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POWER PLANT *Construction News*

Ark., Rose City—Arkansas Power & Light Co., Pine Bluff, Ark., has plans maturing for new addition to Cecil Lynch steam-electric generating station, with installation of turbine generators, high-pressure boilers and auxiliary equipment for large increased output. Cost estimated about $6,800,000, including transmission lines, switching facilities and accessory construction.

Calif., Los Angeles—Board of Water & Power Commissioners, 311 South Spring St., has approved bond issue of $40,000,000 for construction of proposed Owens Gorge hydroelectric power project, comprising three new hydroelectric generating stations, each 37,500-kw capacity, and 265-mile transmission line to city, with switching stations and other auxiliary structures.

Colo., Trinidad—City Council will have plans prepared soon for new municipal power plant, with installation to include turbine-generator, high-pressure boiler and auxiliary equipment. Cost estimated about $1,800,000. Bond issue in that amount has been authorized.

Conn., Waterbury—Connecticut Light & Power Co., Hartford, Conn., has taken out a permit to build addition to generating station on Railroad Hill. No estimate of cost announced. Additional equipment will be installed.

Fla., Lakeland—City Light & Water Dept., is said to be planning expansion and improvements in municipal steam-electric generating station, with installation of equipment for increased capacity. Estimates of cost will be made soon. Charles Larson is manager and engineer.

Ga., Atlanta—Georgia Power Co., will have plans prepared soon for new steam-electric generating station, with installation of turbine-generators, high-pressure boilers and auxiliary equipment for initial rating of about 100,000-kw. Work will include transmission lines and switching stations, and is reported to cost close to $$10,900,000.

Ga., Columbus—Bibb Mfg. Co., cotton goods, has approved plans for new addition to steam power plant at mill, with installation of boiler and auxiliary equipment. Work will be carried out in connection with expansion program at mill and will represent large investment. Main offices are at Macon, Ga.

Ill., Chicago—Peter Fox Brewing Co., 2626 West Monroe St., has plans for new boiler house at brewery, 40 by 70 ft, and equivalent to four stories in height. Proposed to begin work on superstructure during summer. It will be equipped for large capacity. No estimate of cost announced. Commercial Testing & Engineering Co., 307 North Michigan Ave., is engineer.

Ind., Muncie—Indiana General Service Division, Indiana & Michigan Electric Co., Marion, Ind., plans new power substation on Mulberry St., Muncie, with transformers, switchgear and auxiliary equipment for capacity of about 16,000-kw. Cost reported close to $300,000. Work is scheduled to begin soon.

Iowa, Cedar Rapids—Central Iowa Power Cooperative, Cedar Rapids, plans early construction of new generating plant on site near city, to be known as Prairie Creek power station. No estimate of cost announced. It is understood that financing will be arranged through Federal aid. Brown Engineering Co., K-P Bldg., Des Moines, Iowa, is consulting engineer.

Mich., Iron Mountain—Wisconsin Michigan Power Co., 137 West Mill St., Appleton, Wis., has plans maturing for new hydroelectric generating station at Big Quinnesec Falls on Menominee River, near Iron Mountain. No estimate of cost announced. Proposed to begin work on power dam during summer. Mead & Hunt, 550 State St., Madison, Wis., are consulting engineers.

Mo., Rolla—Missouri School of Mines & Metallurgy has plans under way for expansion in steam power plant at institution, with installation of new boiler and auxiliary equipment for central-heating system. No official estimate of cost announced. Rathmann, Koelle & Carroll, 316 North 8th St., St. Louis, Mo., are architects.

Neb., Blair—Town Council has plans under way for expansion in municipal electric power station, with installa-

tion of new Diesel engine-generator unit, and auxiliary equipment. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

Neb., Fremont—Dept. of Utilities, 734 North Park Ave., plans alterations and improvements in municipal steam-electric power plant, with installation of additional equipment. Cost reported close to $500,000. L. M. Roessler is city engineer, in charge.

N. Y., Rochester—Rochester Gas & Electric Corp., 89 East Ave., has plans maturing for new addition to Lakeside generating station, with installation of turbine-generator and auxiliary equipment for increased capacity. Cost estimated close to $5,000,000. Gilbert Associates, Inc., 412 Washington St., Reading, Pa., is consulting engineer.

Okla., Stillwater—State Board of Regents, State Capitol, Oklahoma City, Okla., has plans for new power plant at Oklahoma A. & M. College, Stillwater, for central-heating service. It will be 95 by 115 ft, and 50 ft high. No estimate of cost announced. Coston & Frankfurt, Apco Tower, Oklahoma City, are architects.

Ore., Salem—Oregon State Board of Control, Salem, plans new steam power plant on site between Fairview and Hillcrest State Homes for Girls, Salem, for central-heating service at both institutions. Estimates of cost will be made soon. Dr. Irvin Hall, superintendent, Fairview Home, will be in charge.

Pa., Norristown—Department of Property & Supplies, State Capitol, Harrisburg, Pa., has approved plans for addition to steam power house at Norristown State Hospital, with installation of boilers and other equipment for central steam-heating system. No estimate of cost announced.

Pa., Seward—Pennsylvania Electric Co., Johnstown, Pa., plans new addition, 50 by 115 ft, and 140 ft high, to steam-electric generating station at Seward, for expansion in steam division. New boilers and other equipment will be installed. No estimate of cost announced. Gilbert Associates, Inc., 412 Washington St., Reading, Pa., is consulting engineer.

Pa., West Reading—Metropolitan Edison Co. has tentative plans under consideration for new generating station in West Reading district. Estimates of cost and details will be determined in near future. Gilbert Associates, Inc., 412 Washington St., Reading, is consulting engineer.

S. C., Gaffney—Duke Power Co., Charlotte, N. C., has acquired site on Broad River, near Gaffney, for proposed new steam-electric generating station, to be equipped for initial capacity of 65,000-kw. This is part of power development project recently reported in these columns, to represent total investment of about $20,000,000.

S. C., Iva—Jackson Mills, cotton goods, plans extensions in power facilities in connection with expansion and improvements in textile mill, comprising several new buildings. An air-conditioning plant and system will be installed. Entire project is reported to cost close to $1,000,000.

S. D., Gregory—Rosebud Electric Association, Burke, S. D., plans new power plant in vicinity of Gregory, using Diesel engine-generating unit and auxiliary equipment. Cost reported about $115,000. Proposed to begin work soon.

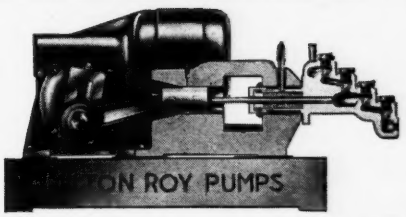
Tenn., Nashville — Nashville Electric Service Dept., Church St., has plans under way for new power substation, with transformers, switchgear and auxiliary equipment for rating of about 63 kv. Cost estimated about $450,000.

Tenn., Richard City—Pennsylvania-Dixie Cement Co., will increase power facilities at local mill in connection with a general expansion program, including new buildings and additional machinery. Entire project will cost approximately $500,000. Main offices are at 60 East 42nd St., New York, N. Y.

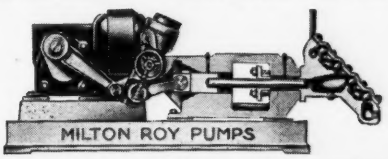
Texas, Carthage—Texas Gas Transmission Corp., Carthage, plans a number of new compressor stations for booster service on natural gas transmission lines, to be located at different points of system. Entire project reported to cost in excess of $3,000,000.

Wash., Seattle—Dept. of City Lighting, 1015 3rd Ave., plans addition to Gorge hydroelectric power plant, including installation of new hydraulic turbines and electric generators for increased output. Cost reported about $3,400,000. Also will build new switching station and transmission line to city to cost approximately $1,500,000.

Wis., Laona—Connor Lumber & Land Co., Laona, plans new electric generating station on local site, using Diesel engine-generator units and accessory equipment. Cost estimated about $165,000. Mead & Hunt, 550 State St., Madison, Wis., are consulting engineers.



Stroke Adjustment—Screw. Liquid End—Alloy.



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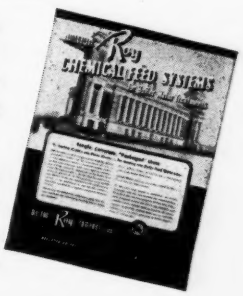

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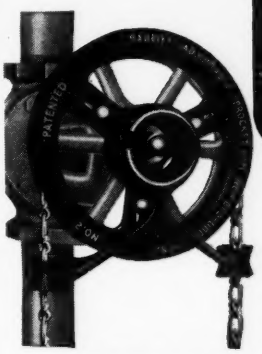

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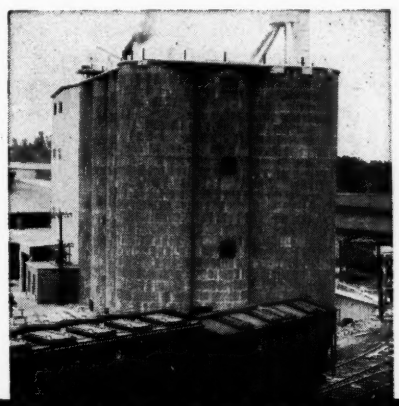

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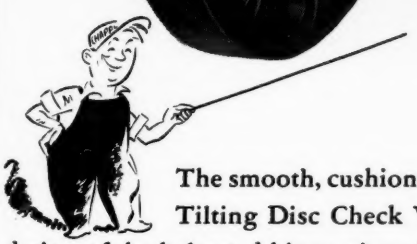
YOU GET A

Smooth, Easy Closing

with CHAPMAN (TILTING DISC) CHECK VALVES



The smooth, cushioned closing of Chapman Tilting Disc Check Valves is based on the design of the balanced hinge-pinned disc. When the valve is open, the disc rides evenly in the flow. On closing, the disc seat drops into contact with the body seat *easily* and *quietly*—cushioned by the effect of the stream against the short flap. Vibrations and destructive stresses in pipe lines are thereby reduced.

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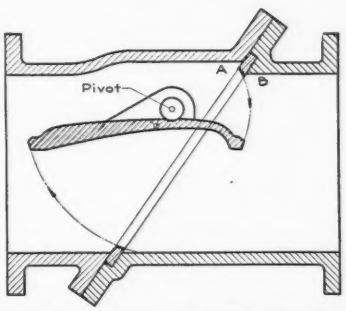
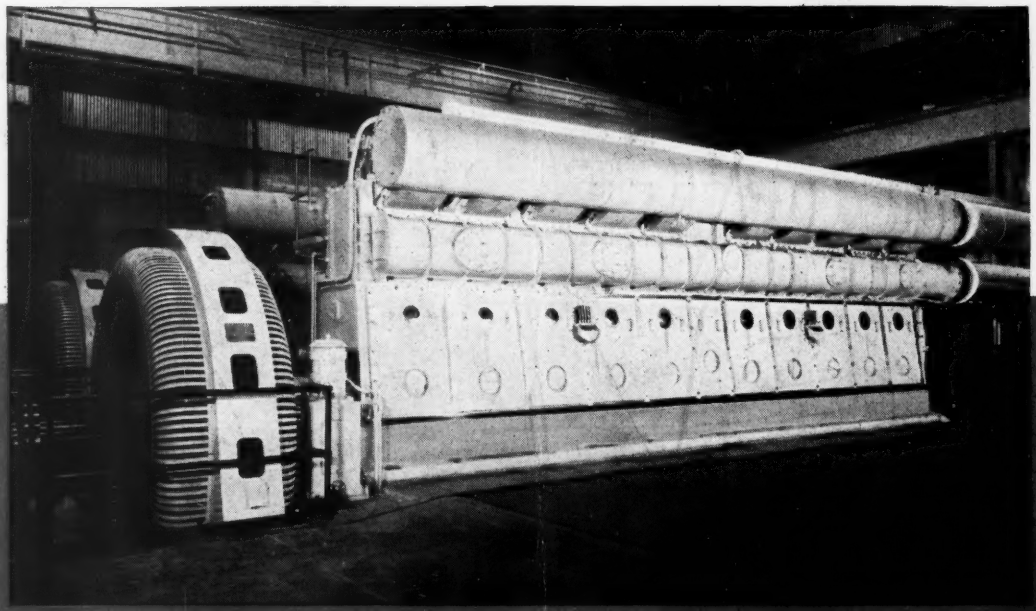


Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

The Chapman Valve Manufacturing Company

INDIAN ORCHARD, MASS.



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